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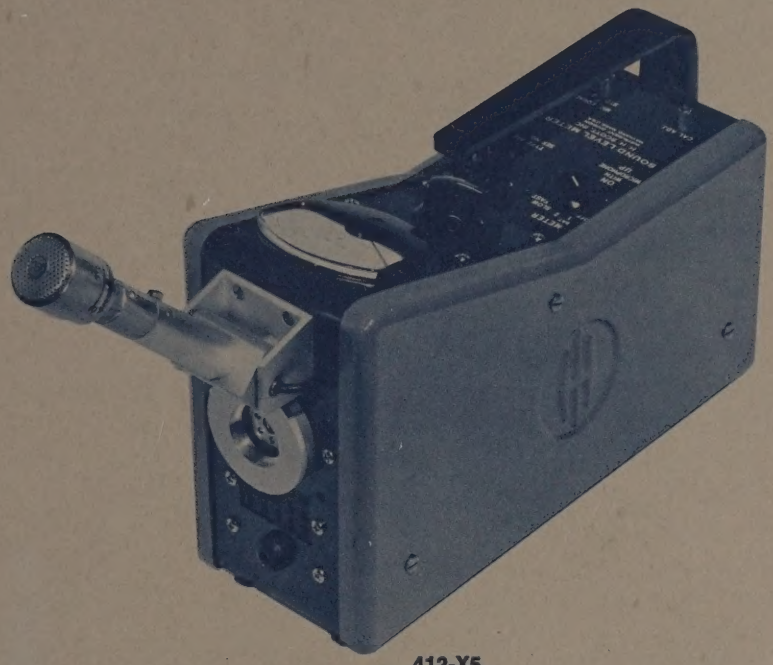
OPERATING INSTRUCTIONS
H. H. SCOTT TYPE 412
SOUND LEVEL METER AND ACCESSORIES



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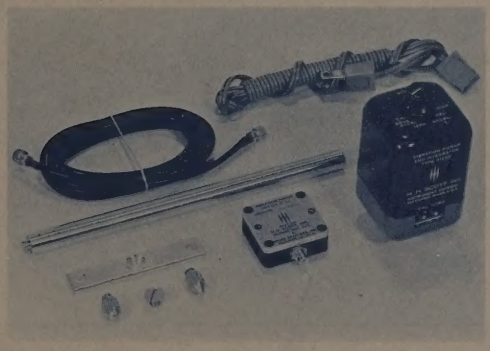

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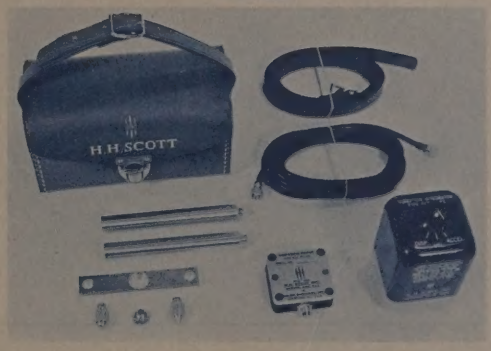

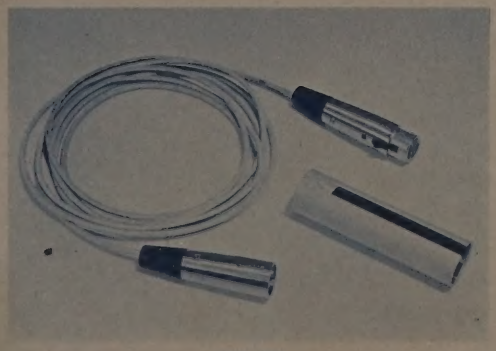

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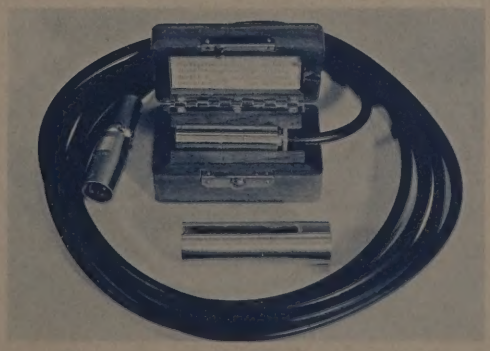

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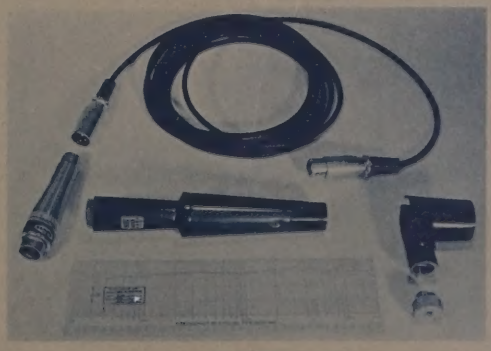

412-X9

SCOTT INSTRUMENT LABORATORIES

A DIVISION OF H. H. SCOTT, INC. MAYNARD, MASS.

NAVSHIPS 0969-102-2010 **D-412-3-67**

INTRODUCTION

Your 412 Sound Level Meter is a precision instrument, carefully manufactured and calibrated in the laboratories of H. H. Scott, Inc. It is the basic component of a *measuring system* which permits rapid and accurate measurement and analysis of sound and vibration.

As a convenience for the user, this Manual covers the operation of most of the Accessories available for use with the 412 Sound Level Meter, as well as the 412 itself. This means operating procedures for these Accessories are always available, and are less likely to be mislaid. It also gives a complete description of the operation and capabilities of these Accessories for owners contemplating adding to their system (more complete than would be possible in Sales Literature).

We suggest you take time *now* to read once through the entire Manual, even the sections on Accessories you do not yet own. This will give you a better idea of the broad scope of application of this versatile Instrument and perhaps suggest uses or applications which might not otherwise occur to you.

Once you are generally familiar with the Manual, specific sections can be found again very quickly by bending the book slightly and noting the black Ready Reference tabs, keyed to the Table of Contents.

Pertinent data on *your* particular Instrument is entered inside the back cover. We strongly suggest you keep this data up-to-date with any additions or changes in the future. There is also space for Service and Calibration Record.

Feel free to contact us at any time regarding your Instrument or its application. Call or write:

Scott Instrument Laboratories Division
H. H. Scott, Inc.
Maynard, Massachusetts 01754, U.S.A.
Phone: (617) 897-8801

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Technical Specifications

TYPE 412 SOUND LEVEL METER

Standards: Meets or exceeds the requirements of the American Standards Association specification S1.4-1961 and International Electrotechnic Commission publication 123, 1961. It will also meet the new ASA standard soon to be issued for Sound Level Meter, type II. Federal Stock Number 6625-649-4828 *

Sound Pressure Level Range: 24 to 150 decibels (re 0.0002 dynes/cm^2).

Frequency Characteristics: Standard ASA weighting networks A, B and C plus a FLAT position where electrical response is –3 dB at 5 Hz and 30 KHz. Useable response to 50 KHz.

Microphone: Supplied with PZT ceramic microphone. Nominal sensitivity –60 dB re lv/microbar and capacity 450 pf. Microphone response 30 Hz to 8 KHz. Accessory microphones available.

Amplification: Voltage gain 108 dB, maximum. Adjustable in steps of 10 dB.

Input Impedance: At microphone connector 45 megohms in parallel with 60 pf.

Output Impedance and Voltage: Open circuit internal impedance at AMP. OUT jack 1500 ohms. Nominal output 0.8 volts RMS (full-scale indication) into 20,000 ohm or greater load impedance. Deviation from linearity by 1 dB occurs beyond 12 dB above full-scale indication.

Internal Noise: For attenuator settings of 60 dB and above, internal noise measured in octave bands, betters the ASA requirement of 40 dB below full-scale indication.

Meter: Quasi-RMS meter circuit. Reads in dB from –6 to +10 dB. Switch selects SLOW or FAST, ASA standard meter damping characteristics. Sound Pressure Level is the sum of the meter reading and attenuator setting. Attenuator is calibrated in 10 dB steps.

External Filters: External filters may be inserted between AMP. OUT and METER IN jacks. Input impedance of meter amplifier (METER IN jack) is 250,000 ohms. With 1500 ohms filter output impedance, there is 70 dB isolation between AMP. OUT and METER IN circuits.

Calibration: Built-in acoustic calibrator and circuit is calibrated in our laboratory against a standard microphone using ASA white noise. Built-in acoustic calibrator placed on the ceramic microphone causes sound level meter to oscillate at 400 Hz at a level of 106 dB SPL. System calibration accuracy meets ASA requirements of ±1 dB.

* FSN 2Z6625-879-1038 Ser. No. 360115 up

Typical Internal Noise Levels* in Equivalent SPL, C Weighting

Attenuator Setting	Overall 20-20KHz	Octave Bands, Hz 20-75	75-150	150-300	300-600	600-1200	1200-2400	2400-4800	4800-9600	9000-20000
30	20	15	7	7	7	8	10	12	14	16
40	22	15	9	9	9	10	12	14	15	16
50	23	16	10	9	9	11	13	14	15	16
60	23	16	10	10	10	11	13	15	16	16
70	25	18	12	12	12	13	15	17	17	17
80	31	23	16	16	16	18	20	21	23	25
90	51	40	40	43	43	44	43	41	39	37
100	54	45	42	43	43	43	44	44	43	45
110	66	56	54	54	55	56	56	57	58	58
120	72	62	57	58	59	60	61	62	63	65
130	84	74	70	71	71	73	75	76	77	78
140	91	82	76	76	76	78	80	82	83	85

*Signal-to-noise ratio (based on FULL-Scale) = (Attenuator setting +10dB)-(noise SPL). Signal-to-noise ratio as an amplifier is **14dB higher,** since amplifier is linear to 14dB **above** full-scale.

Temperature and Humidity: The complete sound level meter and microphone can operate up to 60°C continuously with less than ±1 dB effect on accuracy. The ceramic microphone can operate on its 412X3 Extension Cable without damage in temperatures of −20°C to 80°C and relative humidities of 0 to 100%. The complete meter may operate under conditions of high humidity although prolonged exposure may cause some electrical leakage on printed wiring boards, which generally clears up completely when humidity is reduced.

Microphonics: With the sound level meter hand-held, its microphone replaced by an equivalent dummy, and the instrument subjected to frequencies from 20-10,000 Hz at 100-120 dB SPL, the microphonic pickup is more than 40 dB below the actual SPL. This is 10 dB better than required by ASA standard S1.4-1961.

Power Supply: One 1½ volt D cell (Eveready 950 or equiv.) & one 45 volt "B" battery (Eveready 455 or equiv.). Normal battery life 70 hrs. 412X12 AC Power Supply available as an accessory for operation on 105-125v. 50-400 Hz power line.

Tubes, Transistors and Diodes: Four CK512AX, two 2N3391A, five 2N3964, one QA10(2N3019), one 1N726 (1N973A), four 1N294, and two 1N625.

Dimensions & Weight: 7⅜ x 4⅛ x 12½ in overall. Weight with batteries 8 lbs.

ACCESSORIES SPECIFICATIONS

TYPE 412X1 LEATHER CASE

A sturdy leather case with adjustable shoulder strap for added protection of the 412. 8 High, 5⅛ Wide, 13⅜ in. overall. Weight: case only 2¼ lbs.; case with Sound Level Meter, Instruction Manual, and one set of spare batteries 11¼ lbs.

TYPE 412X2 CALIBRATION CURVE

Consists of: 1) Overall microphone & instrument random-incidence response, in C WEIGHTING, from 20 Hz-10KHz. 2) Electrical response of instrument in FLAT position from 5Hz-50KHz. See typical reproduction Fig. 8.

TYPE 412X3 EIGHT-FOOT EXTENSION CABLE

For ceramic microphone, a low-noise triaxial cable complete with tripod adaptor; weighs 6 oz. No correction factor needed — instrument is re-calibrated with cable installed.

TYPE 412X4 TRIPOD AND CASE

A compact tripod with tilt-top for supporting standard microphone with 412X3 extension cable or accessory microphones. 42" long with legs extended & under 1 ft. collapsed. 1¼ lb. complete in carrying case.

TYPE 412X5 VIBRATION ACCESSORY

Range: Acceleration 0.04 to 30,000 in./sec^2 RMS (0.000001 to 75 g). Velocity 0.006 to 500 in./sec RMS. Displacement 0.0003 to 7 in. RMS. Jerk 700 to 7X10^8 in./sec^3. Calibration chart supplied to convert from dB readings.

Frequency Range: 10Hz-1 KHz and to 5 Hz for acceleration and jerk.

Calibration: Built-in insert calibrator uses 105-125 volt, 50-400 Hz power line.

Pickup Characteristics: Ceramic type. Nominal sensitivity 75 mv/g RMS; capacity 0.01 mfd. Maximum temperature & relative humidity 200°F (93°C) & 100%.

Dimensions & Weight: Vibration integrator (control box) 2 x 2 & 3¾ inches high. Pickup only 1½ x 1⅝ x 9/16 in. thick. 7' pickup cable. Weight complete 1 lb. Pickup weight alone — 1.6 oz. (50 grams).

TYPE 412X5A VIBRATION ACCESSORY

Range: Acceleration: 0.1 to 39,000 in./sec^2. Velocity: 0.0001 to 100 in./sec. Displacement 30 μin. to 1 in. Maximum acceleration must not exceed 100 g. All units RMS.

Readings: In **Vibration Levels** 30 to 150 dB re Reference Levels (0 dB): Acceleration: 3.162 x 10^{-3} in./sec.^{2}; Velocity: 3.162 x 10^{-6} in./sec.; Displacement: 10^{-6} in. All units RMS.

Frequency Range: 20 to 2000 Hz all ranges.

Calibration: Requires external Vibration Calibrator (not supplied).

Pickup Characteristics: Same as used with 412X5.

Dimensions and Weight: 412X5A-P1 Integrator: 2 x 2 x 3¼, weight: 6½ oz. Pickup: same as above. Leather Case: 3 x 3¼ x 5¾. Weight of entire system, in case: 1 lb. 7 oz. FSN 2Z6625-879-1039

TYPE 412X8 WIDE RANGE MICROPHONE

A miniature ADP crystal microphone for high-frequency and/or high intensity measurements.

Frequency Response and Sound Pressure Level Range: Response 10 Hz to 30 KHz grazing incidence. SPL range on 412 Sound Level Meter 75-200 dB.

Microphone meets ASA standards for Type M Laboratory Standard Pressure Microphones.

Maximum Temperature & Relative Humidity: 70°C and 100% relative humidity.

Calibration & Sensitivity: All 412X8 microphones and cables are calibrated and adjusted to deliver the same sensitivity of –106 dB re lv/microbar. Calibration to 412 by direct comparison with standard microphone normally supplied.

Impedance: Microphone & its cable approx. 500 pf source. Cable length must not be altered or calibration will be destroyed.

Dimensions & Weight: Microphone alone; 2⅜" long, 0.624" diameter & weighs 2 oz. Microphone complete with 16' cable, tripod adaptor & wooden storage case weighs 1 lb.

TYPE 412X9 DYNAMIC MICROPHONE SYSTEM

A moving-coil microphone for measurements at considerable distances from the 412. Sensitivity is similar to standard microphone, high-frequency response slightly better.

Frequency Response & Sound Pressure Level Range: Response 45 Hz to 18KHz **normal** incidence, and 45 Hz to 8KHz random incidence. SPL range on 412 Sound Level Meter 24-130 dB. (Includes microphone transformer.) Use with 412 MIC. EQUAL. switch in position 1.

Maximum Temperature & Relative Humidity: Microphone can operate up to 60°C and 100% humidity. Sintered bronze filter eliminates damage by moisture and ferrous filings.

Calibration & Sensitivity: Each microphone is supplied with its sensitivity and normal-incidence frequency response plot from 40 Hz to 18KHz. Nominal sensitivity of microphone & its special miniature input transformer is –60dB re lv/microbar. Microphone sensitivity is originally calibrated in our laboratory against a standard microphone using ASA white noise.

Impedance: Impedance of microphone itself is 200 ohms, isolated from ground. Secondary impedance of shielded miniature input transformer is 200K ohms.

Dimensions & Weight: Microphone only; 1⅛" diameter at top, 7½" long & weighs 10 oz. Input transformer housing 1" diam. & 4" long. System complete with microphone, input transformer, 15' cable, tripod adaptor & wooden storage case weighs 3 lbs.

TYPE 412-X10 DYNAMIC MICROPHONE 100-FOOT EXTENSION CABLE

For remote measurements; up to 5 lengths can be used without affecting calibration.

TYPE 412-X12 AC POWER SUPPLY

Power Input Requirements: 105 to 125 volts, 50 to 400 Hz. 2½ watts @ 117 volts @ 60 Hz. Standard polarized 3-prong male AC plug.

Power Output to 412 Sound Level Meter: Regulated 1.3 volts @ 40 ma. (30 microvolts maximum ripple) for filament. Regulated 45 volts @ 5 to 15 ma. (0.35 millivolts maximum ripple) for B+.

Transistors & Diodes: 2N3019, 2N4033, 2N3964, 1N726 and 11 rectifier-type diodes.

Dimensions & Weight: 5¾ High, 5 long, 4⅝ in. overall. Weight complete 3 lbs.

Type 412 Sound Level Meter

I. Description

A. General

The 412 Sound Level Meter, together with its accessory instruments, constitutes a complete measuring and analyzing system for obtaining full information on the characteristics of noise, sound, or vibration. The 412 is the heart of this system and is used to precisely measure sound pressure level (SPL) at its microphone in terms of decibels. The decibel is a logarithmic unit, expressing the ratio of measured pressure (P) to a standard reference pressure (Po) of 0.0002 dynes/cm^2:

$$SPL = 20 \text{ Log}_{10} \frac{P}{Po}$$

1 dyne/cm^2 = 1 microbar = 74 dB SPL.

The 412 meets or exceeds all requirements of the American Standards Association for sound level meters (S1.6-1961), as well as the International Electrotechnic Commission publication 123, 1961 specification and the specifications for type 2 Sound Level Meters in the new ASA specifications soon to be issued. In addition to being a standard sound level meter, the 412 offers many unique advantages which extend the convenience and utility of the instrument. Included among these outstanding features, and discussed elsewhere in these Operating Instructions, are: Built-in electro-acoustic calibration; standard PZT ceramic microphone; accessory plug which allows use of many additional units; built-in provision for external filters, either passive or active type; extremely wide range amplifier, 5 Hz to over 30 KHz; and transistorized, rugged, modern, and foolproof design.

Basically, the 412 consists of a non-directional ceramic microphone, a calibrated attenuator, a transistorized amplifier, a quasi-RMS indicating meter, an electro-acoustic calibrator, and weighting networks which modify amplifier response to approximate the human ear's response to pure tones at specified sound levels in accordance with ASA requirements.

In addition to its primary use as a sound level meter, the 412 will find application as portable amplifier, voltmeter, or attenuator.

The 412 is a rugged, reliable, precision sound measuring instrument. Thorough familiarization with the operating and check procedures and ordinary care will assure many years of dependable service.

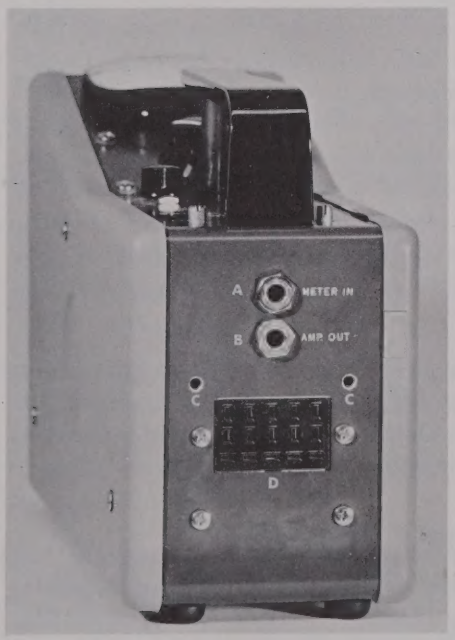


Fig. 1. 412 Back Panel

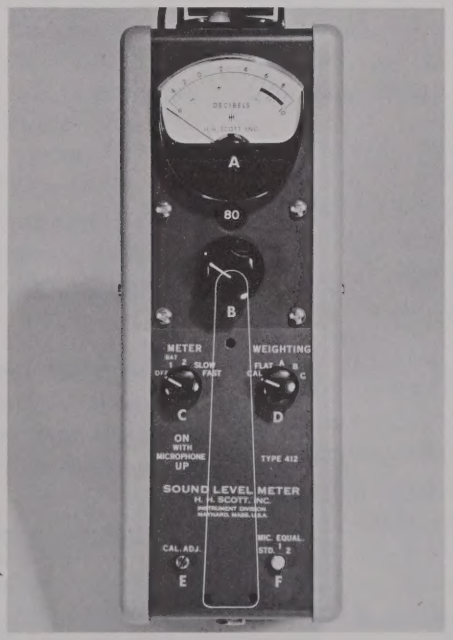


Fig. 2. 412 Top Panel

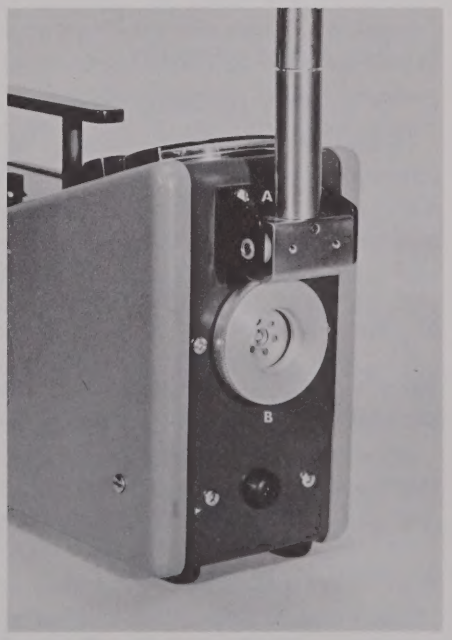


Fig. 3. 412 Front View

B. Controls and Connections

1. Back Panel. See Fig. 1.

a. METER IN Jack

Insertion of a phone plug in this jack opens the internal signal path so that the output from a filter set or analyzer (such as the 420 Half-Octave Band Analyzer) may be read on the 412 meter. This permits frequency analysis with passive filters which do not have their own meters.

b. AMP. OUT Jack

Provides an electrical output proportional to the meter indication. Loads of 100K or over will not affect the accuracy of the internal meter indication. Loads as low as 20K have little effect on gain, but reduce overload capacity by 1 dB. 0.8v RMS output (nominal) corresponds to full scale (+10 dB) meter indication.

c. Screw Holes

For accessory instrument tie-down rods.

d. 15 Prong Receptacle

Along with the METER IN and AMP. OUT jacks, it supplies all required connections for any of the accessory instruments. DC output for a direct writing recorder is also provided at pins 14 and 15. This output is designed to work into a differential input (isolated from ground), 500K ohms or higher. Output is approximately ½ volt for full scale indication. See Service and Maintenance Section H.1.i. and Figure 9, 412 Circuit Diagram.

2. Top Panel. See Fig. 2.

a. Quasi-RMS Indicating Meter

Indication is approximately RMS (root-mean-square) for most wave forms (combines an average-reading circuit with a peak-reading circuit for RMS indication, and reads true RMS values of pure tones and white noise).

b. Main Attenuator

12-position switch selects meter range; 10 dB steps.

c. METER Switch

5-position switch turns instrument ON or OFF (in "UP" position of microphone boom), checks batteries, and selects FAST or SLOW meter response.

d. WEIGHTING Switch

5-position switch provides choice of: A, B, and C weighting; FLAT response (5 Hz to over 30 KHz); and calibration (CAL.) position.

e. CALIBRATION ADJUST

Adjusts gain to calibration point on the meter. Approx. 15 dB range.

f. MICROPHONE EQUALIZATION

This control should normally be left in the STD. position. Position 1 incorporates equalization to improve the response of the 412X9 Dynamic Microphone Accessory. Position 2 has no equalization but increases the gain of the 412 by about 5 dB.

3. Front Panel. See Fig. 3.

a. Microphone Boom

Contains removable microphone and provision for accessory input. When using the internal batteries, the unit is always off when microphone boom is down. The microphone boom has detents to hold the microphone in horizontal, 45°, or vertical positions, as desired. Instrument may be turned ON **only** in these three positions. See Fig. 6.

b. Electro-acoustic Calibrator

Socket contains Invar-diaphragm transducer for calibration checks. Held in place with quarter-turn fastener.

II. Operating Procedure

A. Preliminary Checks

1. Battery check

Turn the 412 on by raising the microphone boom and rotating the METER switch. The BAT 1 position checks the filament battery which is a standard "D" size flashlight cell. The BAT 2 position checks the "B" battery which is a standard 45 volt "B" battery (Eveready 455 or equal). Both should read in the black crescent on the meter labeled BAT. If sufficient battery voltage is not available, replace batteries as described in the Service and Maintenance Sections V.C.1. and 2.

The silver bias cell (Eveready 303) is specifically selected for long life and should last at least two years. It may be checked with a standard voltmeter, as outlined in Section V.C.3.

2. Electro-acoustic Calibration

The 412 contains a built-in electro-acoustic calibrator which allows rapid field calibration of your 412, without expensive accessory equipment. Acoustical calibration should be performed each time the 412 is

used. It should be done under the actual temperature and humidity conditions of use. Recalibrate if temperature or humidity conditions change substantially (e.g. over 25°F.).

a. Remove the calibrator from its storage socket by giving it a **gentle** ¼ turn counterclockwise. Unwind the cord from the back of the calibrator.

b. Place the calibrator over the microphone head (which should be in a vertical position). Rotate the calibrator to insure it is seated squarely. It should seat squarely of its own weight and rotate freely. See Fig. 4.

c. Set the WEIGHTING switch to CAL, the main attenuator to 100-CAL, the METER switch to FAST. (MIC. EQUAL. should be on STD.)

d. The entire instrument will then oscillate at 400 ±50 Hz. This signal can be monitored by plugging high impedance (above 100,000 ohms) earphones into the AMP. OUT jack, and can be heard in quiet surroundings by placing the ear near the calibrator.

e. Adjust the CAL. ADJ. Control so that the meter reads directly on the CAL. line. (When the 412 is set up for calibration, a "scale expansion" of the meter automatically occurs. Thus, what appears to be a 1 dB adjustment is actually only about ½ dB change in operating sensitivity.)

f. When finished calibrating, carefully **roll up** the cord around the spindle of the calibrator, to avoid undue twisting of the cord. Replace the calibrator carefully in its socket and give it a **gentle** ¼ turn clockwise to lock.

g. The 412 is now calibrated and ready for use.

3. Alternate Calibration Procedures

a. The 412 may also be acoustically calibrated with an external oscillator and AC voltmeter. See the Service and Maintenance Section D.1.a. and D.1.b. for instructions.

b. With the sensitivity of your ceramic microphone (given in the back of this Manual) the 412 may be electrically calibrated. See Service and Maintenance section D.2.a. and D.2.b. for instructions.

B. Taking Sound Pressure Level Measurements

1. Conduct the preliminary checks discussed in II.A.

2. Turn the 412 on by raising the microphone boom

Fig. 4. 412 Acoustic Calibration

and by turning the METER switch for either FAST or SLOW meter response. FAST is used for measuring minimum and maximum values of fluctuating sounds and is the position usually used. SLOW provides some damping for measuring the average value of rapidly fluctuating sounds, otherwise difficult to read.

3. Turn the WEIGHTING switch to the desired frequency response A, B, and C weightings. The response in these positions is specified in ASA specification S1.6-1961, and is shown in Figure 5. It is recommended that readings be taken and recorded in all three weighting positions (variation in readings between the A, B, and C networks indicates the relative presence of low frequencies), unless an analyzer such as the Scott 420 is used, in which case, leave WEIGHTING at C.

When a single reading is desired (as in noise control work), it is customary to select weighting to correspond roughly to the human ear's response, as follows: Below 55 dB, A weighting; 55 to 85 dB, B; above 85 dB, C.

Specific applications sometimes dictate certain weighting selections **regardless of SPL**, for example: A is preferred for speech interference measurements; for traffic noise surveys; for aircraft noise surveys, and in general whenever the "noisiness" or "annoyance" factor is desired, **regardless** of the actual SPL; and C for overall acoustic level indication when checking frequency response of loud speakers, sound installations, etc. Never use A or B with an analyzer; use either C or FLAT.

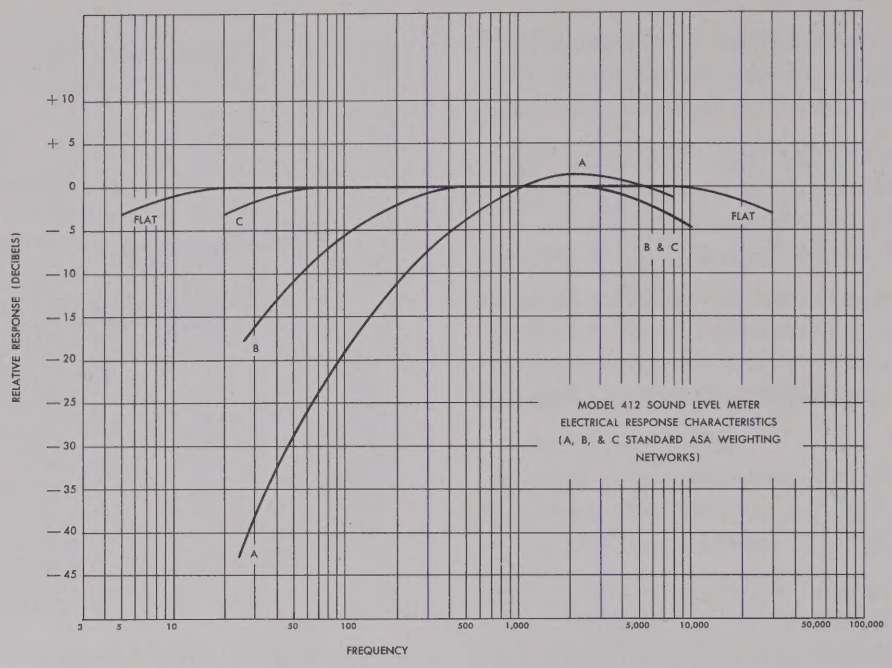


Fig. 5. 412 Electrical Response Curves

The FLAT weighting position may be used to obtain a wider frequency response. Since the electrical response is 3 dB down at 5 Hz and 30 KHz, the instrument's frequency response will normally be determined by the microphone being used. Thus, the FLAT position may be preferred for wide band frequency response or analyzer measurements. When extended-range microphones such as the 412X8 or 412X9 are used, full advantage of the complete system will be obtained by using the FLAT position. Even with the standard ceramic microphone, the FLAT position adds considerably to the response between 10 and 30 Hz and between 8-10 KHz.

4. Position the microphone in one of the positions shown in Fig. 6. The horizontal position is used to get the microphone as far as possible from the operator's body (which can cause errors at higher frequencies) or to get microphone as close as possible to a localized source of sound. ASA Standards specify that Sound Level Meters be calibrated for design-center response for sounds arriving at **Random Incidence** (integrated over **all** directions). The 412 is calibrated this way, and reads accurately in diffuse sound fields with the microphone in any position. For measuring **directional** sounds (free-field, non-reverberant conditions) the microphone should be positioned at such an angle to the direction of the sound source as to **best approximate** the random-incidence response. With this particular microphone,

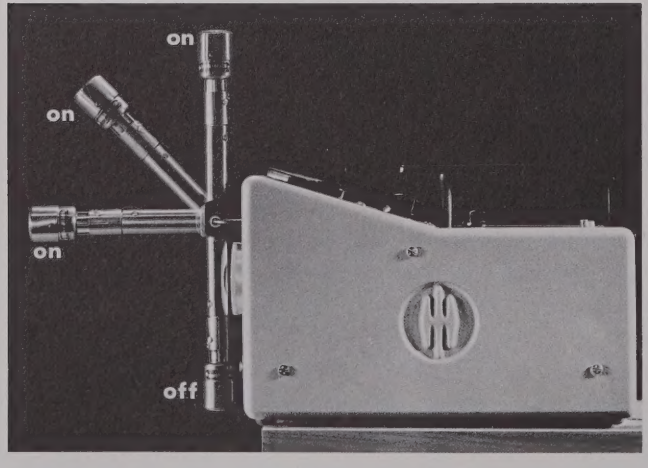


Fig. 6. 412 Microphone Positions

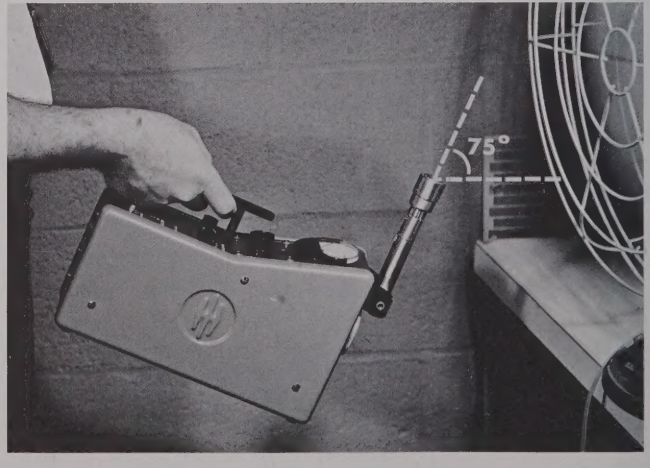


Fig. 7. 412 Normal Position

this angle is about 75° so the "normal" position of the microphone is **vertical** (which results in an angle of about 75° when the 412 is hand held and tilts forward slightly as shown in Fig. 7). The typical response of the 412 with the standard microphone as shown in Fig. 8 is for random-incidence or an angle of incidence of 75°.

5. The attenuator is now set to the position where the meter reads as close to mid-scale as possible. It will not harm the instrument to have the meter needle bang against the stops as the amplifier automatically limits the maximum meter current to a safe value.

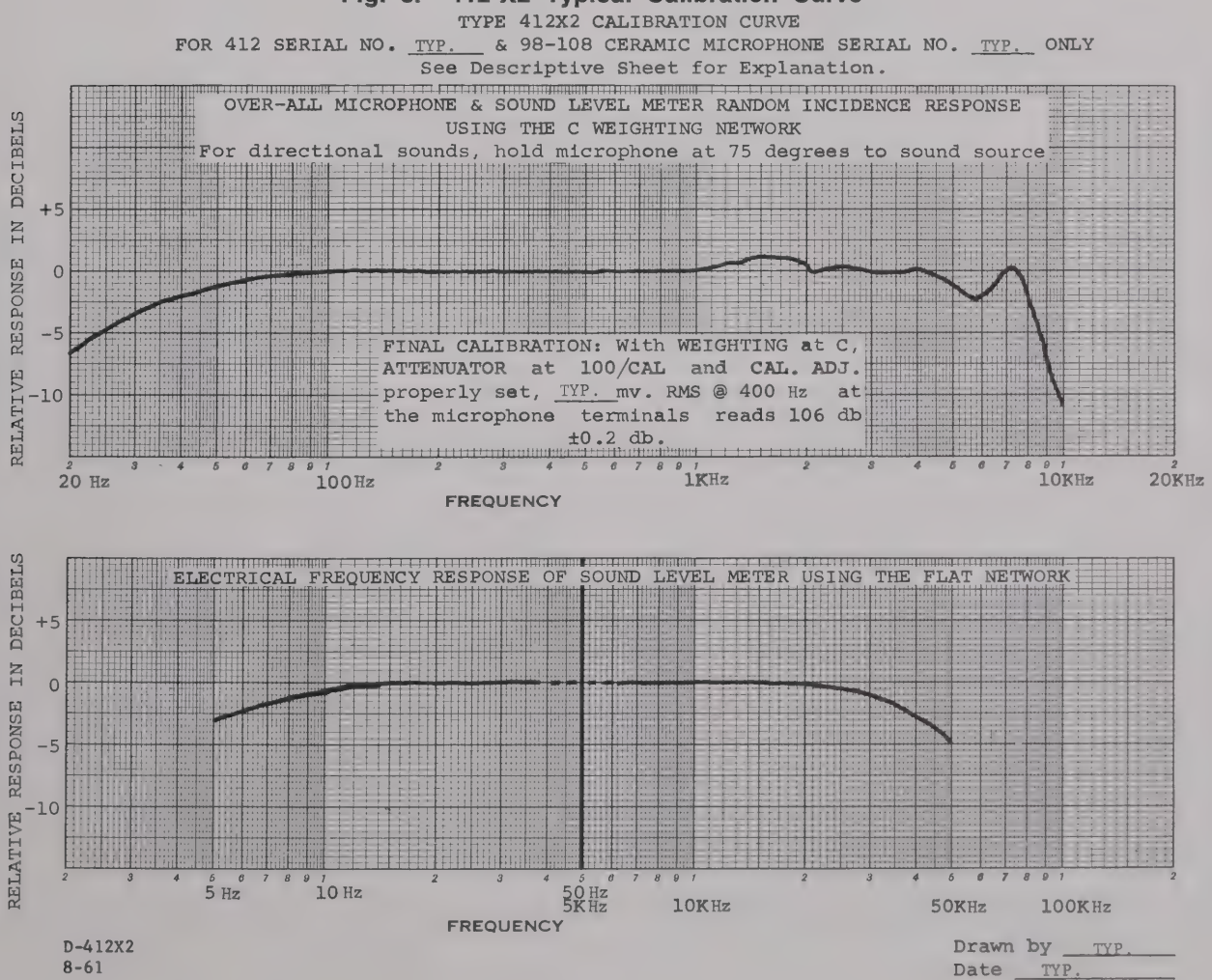
6. **The Sound Level Meter Reading** is the algebraic sum of the meter reading and the setting of the attenuator. This is known as the "Sound Pressure Level (SPL) in Decibels (dB) above 0.0002 dynes per cm^2 RMS Pressure."

7. When making measurements of noise emanating from one source, or several sources that are relatively close together, it is best not to place the 412 between you and the source. With the 412 in such position, the likelihood of errors in the higher frequencies is greater – due to standing waves, etc. Thus, hold the sound level meter away from your body and if possible, off to your side, as you face the source. In diffuse or reverberant sound fields this is not necessary.

8. Microphonics – When high intensity (over 100 dB) sounds are being measured, it is well to put the microphone in the sound field (using 412X3 Extension Cable and 412X4 Tripod) and keep the 412 **out** of the sound field. To quickly check the effect of microphonic excitation on the tubes and frame: (1) Remove the microphone; (2) Set WEIGHTING to A; and (3) Check that there is no meter indication above 70 dB. A more accurate check is to replace microphone with a dummy, described in Service and Maintenance Section E.1.

9. Hum – Electro-magnetic fields can also cause erratic readings. The following check will quickly

Fig. 8. 412-X2 Typical Calibration Curve



determine whether or not stray fields are bothersome: (1) Position the microphone boom in a vertical position in the sound field; and (2) Slowly rotate the 412 in a horizontal plane, using the vertical microphone as a pivot. If readings vary as the 412 is rotated it would be wise to separate the microphone from the 412, using the 412X8 Extension Cable. Then determine a location for the 412 itself which gives minimum reading from the magnetic field. This may also be more accurately checked by replacing the microphone with a dummy, described in Service and Maintenance Section E.1.

10. Carefully record and preserve all readings by noting each of the following: Reading in dB; Weighting used; Microphone used; Exact location of 412 at instant of measurement; Time; and Date.

11. **Turn the 412 OFF** to preserve batteries by lowering the microphone boom and/or setting the METER switch to OFF.

C. Special Applications

1. Portable Decade Amplifier with Attenuator — with WEIGHTING in FLAT, MIC. EQUAL. in STD, and input supplied to the connector in the microphone boom, the 412 may be used as a wide range (5 Hz to over 30KHz) voltage amplifier in the FLAT WEIGHTING position. Maximum gain (about 100 dB) is obtained with main attenuator in 30 dB position. Sensitivity is about 20 microvolts for a full scale reading of 1 volt RMS. The amplifier can stand 10 dB overload. 110 dB attenuation is available using the main attenuator. The CAL. ADJ. potentiometer gives an additional 15 dB range of adjustment. Output is available at the AMP. OUT jack. The WEIGHTING networks may be used to eliminate low- or high-frequency noise, depending upon the frequency you are measuring. See Fig. 5, 412 Electrical Response Curves. See Service and Maintenance Section D.3. for calibrating the 412 as an amplifier.

2. Portable Voltmeter—With input again supplied to the microphone connector and WEIGHTING in FLAT, the 412 is useful as a highly sensitive AC voltmeter with a range from approximately 20 μV to 6 v. RMS. When calibrated against a known voltage, readings over a 120 dB range are possible. The WEIGHTING networks may be used to eliminate low or high frequency noise, depending upon the frequency you are measuring. See Fig. 5, 412 Electrical Response Curves. See Service and Maintenance Section D.3. for calibrating 412 as a voltmeter.

III. Accessories — Instructions

A. 412-X1 Leather Carrying Case

Specially designed for convenient use with the 412 Sound Level Meter, the 412X1 is constructed of top-grain cowhide, lined, with heavy saddle stitching. Space is provided for recording paper, Instruction Manual, and one set of spare batteries (slipped under the 412 handle). An adjustable shoulder strap is included.

B. 412-X2 Calibration Curve

Individually drawn in our laboratory, the 412X2 provides precise response data for a particular microphone and 412 Sound Level Meter. Exact electrical frequency response of the 412 amplifier and a descriptive sheet is also supplied. See Fig. 8 for a typical 412X2 Calibration Curve.

C. 412-X3 Extension Cable

Provides for remote measurements up to 8 ft. from the 412. After installation, electro-acoustic calibration (as described in II.A.2.) should be performed. Thus, correction factors due to cable length or environmental temperature are not required, and direct SPL readings can be taken. A tripod adaptor is included, permitting mounting the microphone on the 412X4 tripod. See Service and Maintenance Section D.1. and D.2. for an alternate calibration procedure.

D. 412-X4 Microphone Tripod and Case

Legs may be pulled out to any desired length, up to about 42". When fully extended, lock top section by turning clockwise. To collapse, turn top section ½ turn counterclockwise and push in from the foot. If used partially extended, be sure to extend the top locking section and as many **adjacent** sections as required, leaving smaller sections collapsed. Do not force. The tripod is equipped with a built-in tilt-top and comes in a zipper carrying case.

E. 412-X12 AC Power Supply

Operating Instructions:

1. Remove **left** side pan on 412. See Service and Maintenance, B.1. and Fig 14.

2. Remove both batteries or disconnect 9-contact battery power connector from P1 at rear of 412. See Fig. 14, Interior View of 412. If the 412 will be used on AC for extended periods (months) it is advisable to **remove** the batteries to avoid damage to the instrument if and when the batteries deteriorate.

3. Replace left side pan on 412.

4. Line up plugs 412X12 with sockets on 412 and insert. (Do not plug into power line yet).

5. Screw in tie rods to positively attach 412X12 to 412.

6. When ready to take sound measurements, plug polarized AC plug into 105-125V, 50-400 Hz line.

7. The complete 412 Sound Level Meter and 412X12 AC Power Supply is turned ON and OFF by the red slide switch on the 412X12. Note that METER switch on the 412 does **not** turn instrument power off in OFF position. Microphone boom switch also **inoperative** during AC operation. Battery voltages 1 and 2 may be checked as with battery operation (Section II.A.1. above).

8. In all **other** respects operation is the same as battery operation.

F. Use of 412 Sound Level Meter with Accessory Analyzing Instruments

1. **Sound Analyzers**—The 420A Half-Octave Sound Analyzer and other standard units may be used with the 412 Sound Level Meter to provide octave, half-octave, third-octave, or narrow band analysis. The excellent signal-to-noise ratio of the 412 makes it ideal for use with analyzers. The 420 Sound Analyzer has its own meter and readings may be made on the 420 or the 412 meter as desired.

The analyzer is connected to the AMP. OUT jack with a patch cord (supplied with the 420). If readings are to be made on the 412 meter, a **second** patch cord is required to connect the OUTPUT jack of the 420 to the METER IN jack on the 412. Similar arrangements would apply to other analyzers. Their input impedance should be 20 K ohms **or greater,** and output impedance 20 K **or less.** 600 ohm filters are **not** suitable.

2. **Special filters** for particular applications may be designed and constructed for insertion into the 412 circuitry. Signals may be taken from the AMP OUT jack to be passed through the filter and returned for meter reading to the METER IN jack. Several precautions should be observed when employing such filters.

a. Input impedance of filter should be preferably 100K or above, but not less than 20K at all frequencies concerned.
b. Output impedance should be 20K or less.
c. Voltage gain should be adjustable to unity although 412 may be adjusted to accommodate filters with losses up to about 6 dB.

3. **Recorders** — standard graphic level recorders may be used to provide a visual record of the sound being measured. Two general types of recorders may be used: (1) Logarithmic graphic level recorders which use the sound level signal from AMP. OUT jack and give dB; (2) Strip-chart DC milliammeter recorders which use a varying DC level. This DC signal may be obtained from pins 14 and 15 on the accessory plug and, thus, will give a visual record of the amplitude of the sound level signal. However, range is pretty well limited to the meter scale range (16 dB), without range switching.

4. **Tape Recorders** — For legal and detailed analysis, a magnetic tape recording may be made using output from the AMP. OUT jacks. Recorder sensitivity should be approximately 1 volt with an input impedance of 20K or greater. If a VU meter is available on the tape recorder, calibrate the 412 and adjust recorder sensitivity for a —4 VU reading with the calibrating signal. This calibrates the tape recorder and prevents overloading. **Record** this signal on the tape for subsequent calibration of the playback level.

5. **Oscilloscope** — An oscilloscope may be used by taking the signal from the AMP. OUT jack. Almost all oscilloscopes will have sufficiently high input impedance and adequate sensitivity.

6. **Headphones** — useful to ensure that **desired** signal is actually what is being measured. Use the high-impedance crystal type; connect to AMP. OUT jack.

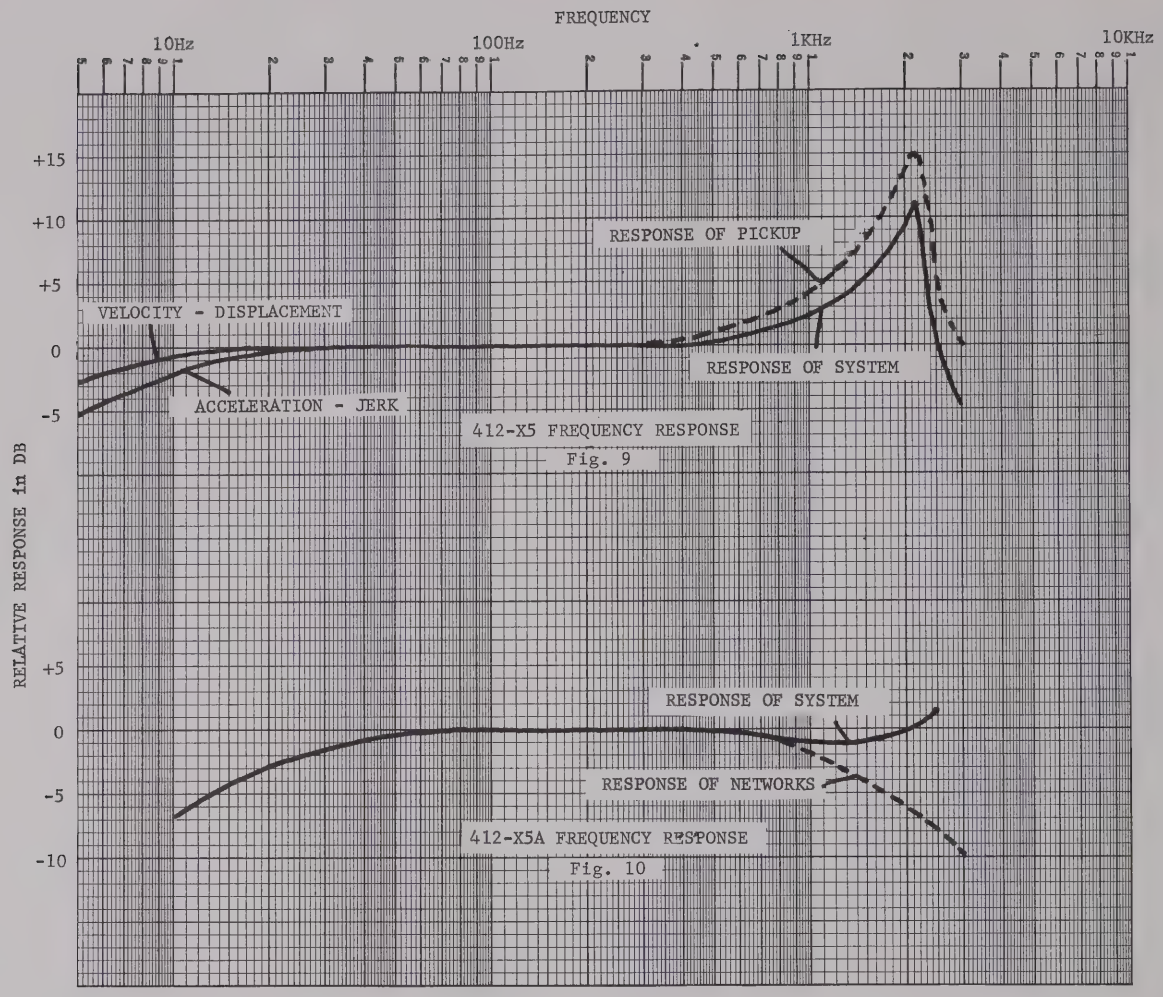


Fig. 9. 412-X5 Frequency Response

Fig. 10. 412-X5A Frequency Response

IV. Operation With Vibration Pickups and Accessory Microphones

A1. 412-X5 Vibration Accessory

The exceptionally wide frequency response of the 412, combined with the high quality ceramic pickup (only 1.6 oz. in weight) and carefully designed integrator, produce a vibration accessory for the 412 virtually equal in performance to many vibration meters. It is extremely useful in pinpointing specific sources of sound and areas of high vibrational stress that lead to component failure.

The 412X5 consists of: Vibration pickup Part 412X5-P2 extension aluminum rod, ball-tip, point-tip and mounting bracket; 7-foot detachable shielded pickup cable; vibration integrator; calibration cord; and Form D-412X5 Calibration Chart.

The vibration pickup Type 412X5-P2 is a ceramic type whose electrical output is proportional to the acceleration of the vibration. In order to determine the velocity or displacement, it is necessary to integrate the electrical output of the pickup once or twice, respectively. In order to determine the jerk (time rate of change of acceleration), it is necessary to differentiate the electrical output of the pickup once. All of this is done by networks in the vibration integrator. These networks are adjusted in our factory to the sensitivity of the particular pickup. Electrical calibration with the 412 Sound Level Meter is made possible by merely taking a signal from any power line, that is from 105-125 volts and 50-400 Hz. The factory-adjusted networks and electrical calibrator allow the use of the standardized Calibration Chart, Form D-412X5. Be sure to match the serial numbers of the Pickup and Integrator properly as shown at the top of the chart (and on the Integrator) or inaccurate readings will result.

All readings with this equipment **are in RMS units.** Sometimes vibration is measured in terms of "double amplitude" (peak-to-peak). For sinusoidal vibration, to convert RMS readings to peak-to-peak amplitude, multiply by 2.8.

Operating Instructions:

1. Remove microphone from 412 and plug in vibration integrator 412X5. Connect vibration pickup 412X5-P2 to integrator with 7-foot cable supplied.

2. Calibrate the system as follows:

a. Set 412 WEIGHTING to FLAT, main attenuator to 100 CAL., MIC. EQUAL to STD. Check 412 batteries (section II.A1.).

b. Set integrator function switch to CAL. Connect calibration cord to integrator and power line. (105-125 volts and 50-400 Hz is acceptable).

c. Adjust CAL. ADJ. on 412 to produce a meter reading on CAL. or 106 dB.

d. Remove calibration cord from the power line and integrator. Instrument is now ready for use.

3. Use the appropriate setting of the function switch — displacement (DISP.), velocity (VEL.), acceleration (ACCEL.), JERK, or sensitive acceleration (SENS. ACCEL.). This last position utilizes full sensitivity of 412X5-P2 pickup, and is used for very low acceleration readings down to 0.04 inches/sec^2. The ceramic pickup may be permanently mounted or hand held. The point-tip may be used for point-to-point exploration, while the round-tip can be used in checking surfaces for smoothness. Remote parts of machinery may be reached by using the extension rod. When hand held, only enough pressure should be applied to the pickup to keep it firmly in place. Excessive pressure may alter the amplitude of vibration observed and give erroneous readings.

4. **Do not use pickup where vibration exceeds** the **limits** given on the calibration chart, Form D-412X5. Vibrations exceeding 28,900 inches/sec^2 or 75 g acceleration (125 dB on Sound Level Meter, with integrator function switch on ACCEL.) can permanently damage the ceramic vibration pickup. If vibration is intense, **always** cautiously measure acceleration **first** with ball-tip and remove pickup from the body **at once** if reading is over 125 dB for ACCEL. and over 140 dB for SENS. ACCEL.

5. Record results in terms of 412 SPL reading and position of 412X5 Integrator switch.

6. Convert from 412 dB readings using the D-412X5 Calibration Chart supplied. For example: a reading of 103 dB on the SENS. ACCEL. position is equivalent to 1 g acceleration or 386 inches/sec^2 RMS.

7. The maximum output of the pickup is obtained when the direction of displacement is perpendicular to the flat surface of the pickup. When the extension rod is used, the readings obtained will represent the component of vibration parallel to the axis of the rod. When the mass of the vibrating body being measured approaches the mass of the pickup (1.6 ounces), it must be remembered that application of the pickup may greatly alter the characteristics of the vibration.

8. Bear in mind that the frequency limits of measurement with this equipment for acceleration and jerk are 5 Hz to 1 KHz and for displacement and velocity are 10 Hz to 1 KHz. See Fig. 9, 412X5 Vibration Accessory Response Curve.

A2. 412-X5A Vibration Accessory

The new 412X5A Vibration Accessory comprises the 412X5A-P1 Integrator, 412X5-P2 Pickup, 7-foot cable, probe rods (2), ball-tip, cone-tip, mounting plate and screw; all in fitted leather case. It is similar to the 412X5, described in section A1, **except:**

1. Readings are for ACCELERATION, VELOCITY and DISPLACEMENT only (no JERK or SENS. ACCEL. positions).

2. Readings are in **Vibration Level in dB** re standard reference levels — no conversion chart is supplied or required.

3. There is no provision for internal electrical calibration. System is calibrated by using an external vibration calibrator (**not** part of this Accessory Group).

4. The probe rod has been divided in two sections for easy storage and these may be used singly or together. The pickup used is the same as supplied with 412X5, Part 412X5-P2.

5. Frequency range of the 412X5A combined with the 412 is 20 Hz to 2000 Hz **on all ranges.** Response below and above this range is purposely reduced to avoid spurious readings. See Fig. 10, 412X5A Frequency Response.

The 412X5A indicates vibration levels with respect to the following reference levels:

Switch Position	Reference Levels
ACCELERATION:	0 dB = 3.162×10^{-3} in./sec^2 RMS
VELOCITY:	0 dB = 3.162×10^{-6} in./sec RMS
DISPLACEMENT:	0 dB = 10^{-6} inches RMS

Measurement Range	
MIN. (30 dB)	MAX.*
0.1 in./sec^2	39,000 in./sec^2
10^{-4} in./sec	100 in./sec
30 μ inches	1 inch

Since there is a second set of "standard" reference levels in current use, conversion figures are given on the 412X5A which should be **added** to the vibration level indicated on the 412 when converting to these "standard" levels:

ACCELERATION: to convert to 0 dB = 10^{-3} cm/sec^2
ADD 18.1 dB to 412 reading

VELOCITY: to convert to 0 dB = 10^{-6} cm/sec
ADD 38.1 dB to 412 reading

DISPLACEMENT: to convert to 0 dB = 10^{-6} cm
ADD 8.1 dB to 412 reading

In recording or reporting results be sure to clearly specify **which** reference levels are used.

Actual physical vibration units may, of course, be determined from vibration levels using the equation:

$$V.L. = 20 \log_{10} \frac{V}{Vo}$$

or $$V = Vo \text{ antilog } \frac{V.L.}{20}$$

Where V.L. = Vibration Level in dB.
V = actual vibration (ACCEL, VEL, or DISP units).
Vo = Reference Vibration Level (ACCEL, VEL, or DISP units).

Operating Instructions:

1. Remove the microphone from 412, install the 412X5A-P1 Integrator on the microphone boom (in vertical position), connect the 412X5-P2 Vibration Pickup to the 412X5A-P1 Integrator with the 7-foot cable supplied. Set the 412X5A-P1 to ACCEL.

2. Calibration to the 412 may be accomplished in two ways: by comparison with a calibrated accelerometer on any vibration within the flat range, or by using a standard vibration calibrator such as the General Radio 1557A or equivalent. In the first method, it is essential to ensure that both pickups are subjected to **identical** vibration and there is no possibility of **relative** motion between them. Error from this source will be minimized if the vibration used for calibration is kept low in frequency (400 Hz or less) and as nearly a pure sine-wave as practical. The second method is far simpler and for that reason, generally more satisfactory. The procedure is given for the G.R. 1557A, but would apply generally to other similar calibrators suitable for a pickup load of 50 grams.

a. Check battery condition of the 1557A per instructions supplied with the unit.
b. Remove **one** (either) 50-gram disc from the 1557A and screw on the 412X5-P2 pickup in its place. (It may be easier to remove the cable from the pickup, screw it on the calibrator, and reconnect the cable.) See that the cable loops or hangs **freely** from the pickup so as not to restrict motion or add mass to the pickup. The calibrator may be used in a vertical or horizontal position.
c. Turn the calibrator switch to ON and adjust calibrator LEVEL control to obtain a reading of 100 or "B" on the calibrator meter. The calibrator is now applying exactly 1 g or 386 in./sec^2 acceleration at 100 Hz to the pickup.
d. Set the main dial of 412 to 100-CAL (METER switch on FAST, WEIGHTING on FLAT, EQUAL. on STD.) and adjust CAL. ADJ. for a reading of 101.8 dB which is the vibration level for 1 g, re the reference level of 3.162×10^{-3} in./sec^2. RMS.
e. Switch the 412X5A-P1 to VEL. and 412 main dial to 80. The 412 Meter should read 85.8 $\pm$ 1 dB. Switch 412X5A-P1 to DISP., 412 to 60; meter should read 60 $\pm$ 1 dB. (These last two checks are critically dependent on exact calibrator frequency, a 1% error in frequency causes a 0.1 dB change in VEL. reading and a 0.2 dB change in DISP. reading.)
f. Check that the calibrator meter still indicates "100-B." If not, reset and repeat (d) and (e). If the calibrator level falls off **too** rapidly, replace the battery — see Calibrator Instructions.
g. Turn the calibrator OFF and remove the pickup from the calibrator. The pickup is now calibrated to the 412 and ready for use.

3. Operation. The operation is similar to the 412X5. The pickup may be hand-held against the vibrating structure or screwed or clamped to it. For very mild vibrations, it may be fastened to rigid flat surfaces with "double sticky" tape (pressure sensitive adhesive both sides) manufactured by 3M, Permacel, Mystic and others.

4. Observe the same precautions regarding **inti-**

* Limited by maximum acceleration pickup can withstand, which is 100 g or 39,000 in./sec^2 (142 dB). On VEL., limit depends on frequency; 100 in./sec. (150 dB) may be measured only at frequencies *below 62 Hz.* On DISP., 1 inch (120.5 dB) may be measured only at frequencies *below 32 Hz.*

mate contact, mass loading by pickup itself and **maximum safe vibration** as outlined in sections IV.A1.4, 5, and 7 above.

5. The 412X5A-P1 Integrator is packed in a plastic bag in the 412X5A-P3 case. It should be **re-packed in this bag** when replacing the Integrator in the case, to avoid scratching of the Integrator finish by the hardware in the bottom of the case, or the connectors on the connecting cable. The cable is coiled and placed **behind** the Integrator, next to the case flap.

B. 412-X8 Wide Range Microphone

This accessory permits sound level measurements from 75 to 200 dB SPL over the full frequency range of the 412 amplifier (10 Hz to 30 KHz). It meets the requirements of ASA Z24.8 — 1949 for Laboratory Standard Pressure Microphones, Type M. Its extremely smooth frequency response and excellent transient response make it an excellent low-cost, rugged, general purpose, standard microphone capable of making simple, direct, accurate measurements of high sound pressure levels and blast pressures. A typical response curve may be seen in Fig. 11. Note that this microphone has best (flattest) response at **grazing** incidence (90°).

Operating Instructions:

1. There are two field calibration methods that may be used, one of which requires a steady source of noise. In each case a correction factor must be added to the 412 reading to obtain the actual Sound Pressure Level. This is because the nominal sensitivity of the ceramic microphone supplied is —60 dB re 1V./microbar and for the 412X8 it is —106 dB re IV./microbar. In other words the output of the 412X8 is about 46 dB less than the standard microphone.

2. Calibration — First Method:

a. Calibrate the 412 with the ceramic microphone as covered in section II.A.2.

b. Remove the ceramic microphone and replace it with the 412X8.

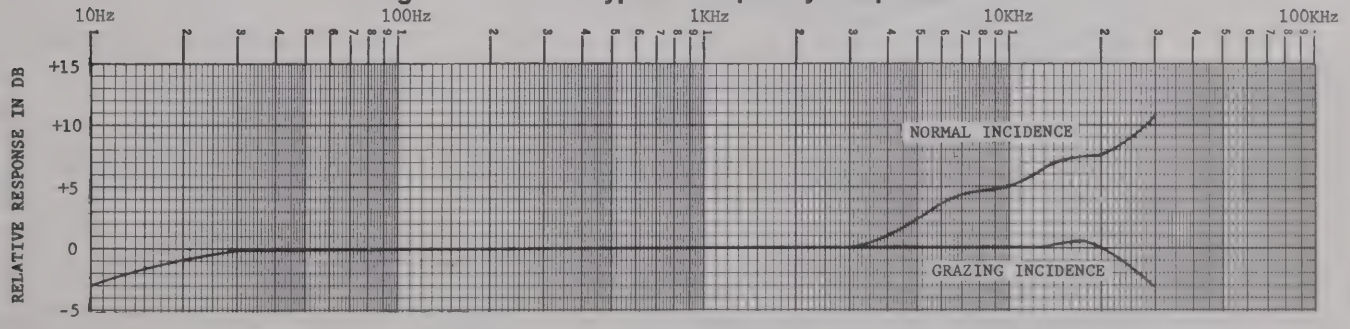
c. When the 412X8 replaces the original ceramic microphone, the dB difference in microphone **effective** sensitivities must be added to the 412 Sound Level Meter reading to obtain the correct sound pressure level. For example, if the ceramic microphone effective sensitivity is —60 dB, then the correction factor to add to the sound level meter reading is 46 dB (106-60). Microphone effective sensitivities are given on the inside back cover of this instruction manual. Check the serial # of the ceramic microphone to be sure it is the one for which sensitivity is given. The effective sensitivity of the 412X8 is always —106 dB. (Do **not** use the open-circuit sensitivity of the ceramic microphone for this comparison).

d. Use the 412 Sound Level Meter and take readings using the 412X8 microphone as covered in Sections II.A. and II.B.

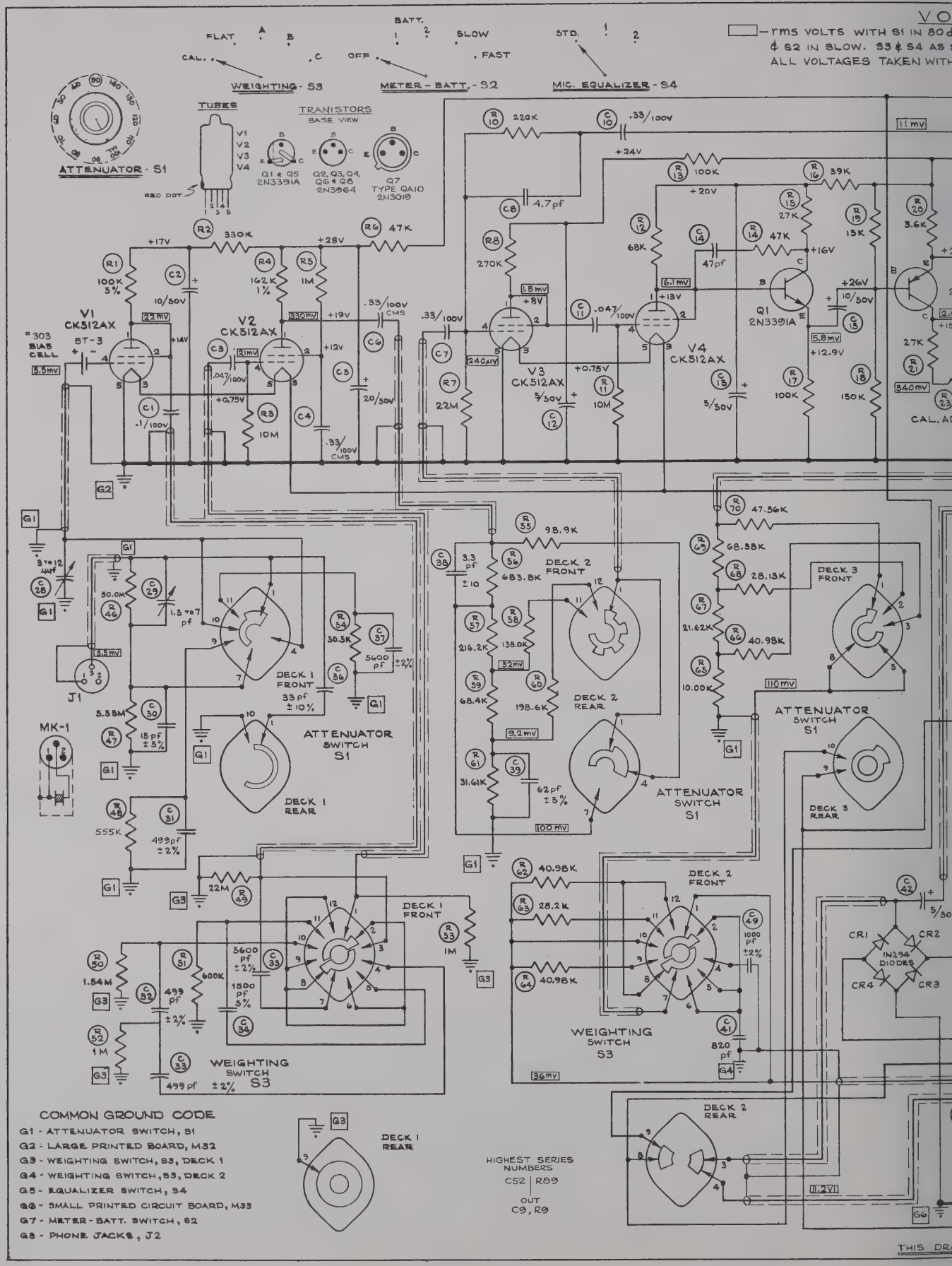
e. Add the correction factor, determined in (c) above. to the Sound Level Meter reading to obtain the actual sound pressure level (SPL).

f. Remember that at high frequencies (above 4 KHz) the frequency response varies with angle of incidence of the approaching sound. The response at zero or normal incidence is higher than response for grazing or 90°. See Fig. 11, Free-Field Response of 412X8 Microphone. You will note that grazing incidence is the best response. Grazing or 90° incidence is sound approaching the microphone at right angles to its long axis. There is a resonant peak around 35 KHz.

Fig. 11. 412-X8 Typical Frequency Response



FREQUENCY RESPONSE OF 412X8 WIDERANGE MICROPHONE WITH 412 SOUND LEVEL METER IN FLAT WEIGHTING NETWORK


VO
rms VOLTS WITH S1 IN 80d
& S2 IN SLOW. S3 & S4 AS
ALL VOLTAGES TAKEN WITH
BATT.
FLAT
SLOW
STD.
CAL.
OFF
FAST
WEIGHTING - S3
METER - BATT. - S2
MIC. EQUALIZER - S4
ATTENUATOR - S1
TUBES
V1
V2
V3
V4
RED DOT
TRANSISTORS
BASE VIEW
Q1 & Q5
2N3391A
Q2, Q3, Q4,
Q6 & Q8
2N3964
Q7
TYPE QA10
2N3019
"303
BIAS
CELL
V1
CK512AX
V2
CK512AX
V3
CK512AX
V4
CK512AX
Q1
2N3391A
+17V
+28V
+24V
+20V
+19V
+16V
+13V
+12V
+12.9V
+26V
+8V
+0.75V
+14V
330K
47K
100K
5%
162K
1%
1M
10M
22M
270K
68K
47K
27K
39K
15K
3.6K
2.7K
150K
100K
10M
220K
.33/100V
.1/100V
.047/100V
4.7pf
47pf
10/50V
20/50V
5/50V
.33/100V CMS
240µH
11 mv
1.5 mv
6.1 mv
5.8 mv
5.4 mv
22 mv
21 mv
330 mv
5.5 mv
CAL. AT
G1
G2
G3
G4
G6
J1
MK-1
3 to 12 µµf
1.5 to 7 pf
50.0M
5.58M
555K
15 pf ±5%
499 pf ±2%
33 pf ±10%
5600 pf ±2%
DECK 1 FRONT
DECK 1 REAR
ATTENUATOR SWITCH S1
98.9K
683.8K
216.2K
68.4K
31.61K
3.3 pf ±10
138.0K
198.6K
62 pf ±5%
DECK 2 FRONT
DECK 2 REAR
50.3K
5600 pf ±2%
47.56K
68.38K
28.13K
21.62K
40.98K
10.00K
DECK 3 FRONT
DECK 3 REAR
110 mv
52 mv
9.2 mv
100 mv
36 mv
1.54M
600K
499 pf ±2%
1500 pf 5%
1 M
499 pf ±2%
5600 pf ±2%
1M
WEIGHTING SWITCH S3
40.98K
28.2K
40.98K
1000 pf ±2%
820 pf
CR1
CR2
CR3
CR4
IN294 DIODES
11.2V
HIGHEST SERIES NUMBERS
C52 | R89
OUT
C9, R9
COMMON GROUND CODE
G1 - ATTENUATOR SWITCH, S1
G2 - LARGE PRINTED BOARD, M32
G3 - WEIGHTING SWITCH, S3, DECK 1
G4 - WEIGHTING SWITCH, S3, DECK 2
G5 - EQUALIZER SWITCH, S4
G6 - SMALL PRINTED CIRCUIT BOARD, M33
G7 - METER - BATT. SWITCH, S2
G8 - PHONE JACKS, J2
THIS DR

GE CODE

[ ] – rms VOLTS & dc VOLTS WITH S1 IN 100db POSITION & S2, S3, S4 AS BEFORE. ACOUSTICAL CAL. ON MIC. ALL VOLTAGES TAKEN WITH 10M VTVM AT 400 Hz.

AT 400 Hz.

ECO 1557 10-26-66 Appr.	10	ECO #708 7/20/62 W.C.	6	ECO #638 11/20/61 DR.	3	REVISIONS	
ECO 1638 1-5-67 Appr.	11	ECO #765 11/27/62 DR	7	ECO #648 1/4/62 J.G.	4	REVISED PER ECO # 606 9/25/61 Rum	1
ECO 1670 2-2-67 Appr.	12	PER ECO #971 9-3-69 JAL	8	ECO #698		ECO #616 9/27/61 Rum	2
ECO 1678 Appr.	13	PER ECO #927 4-7-64	9	6/29/62 J.V.G.	5		
ECO 1717 APPR.	14						

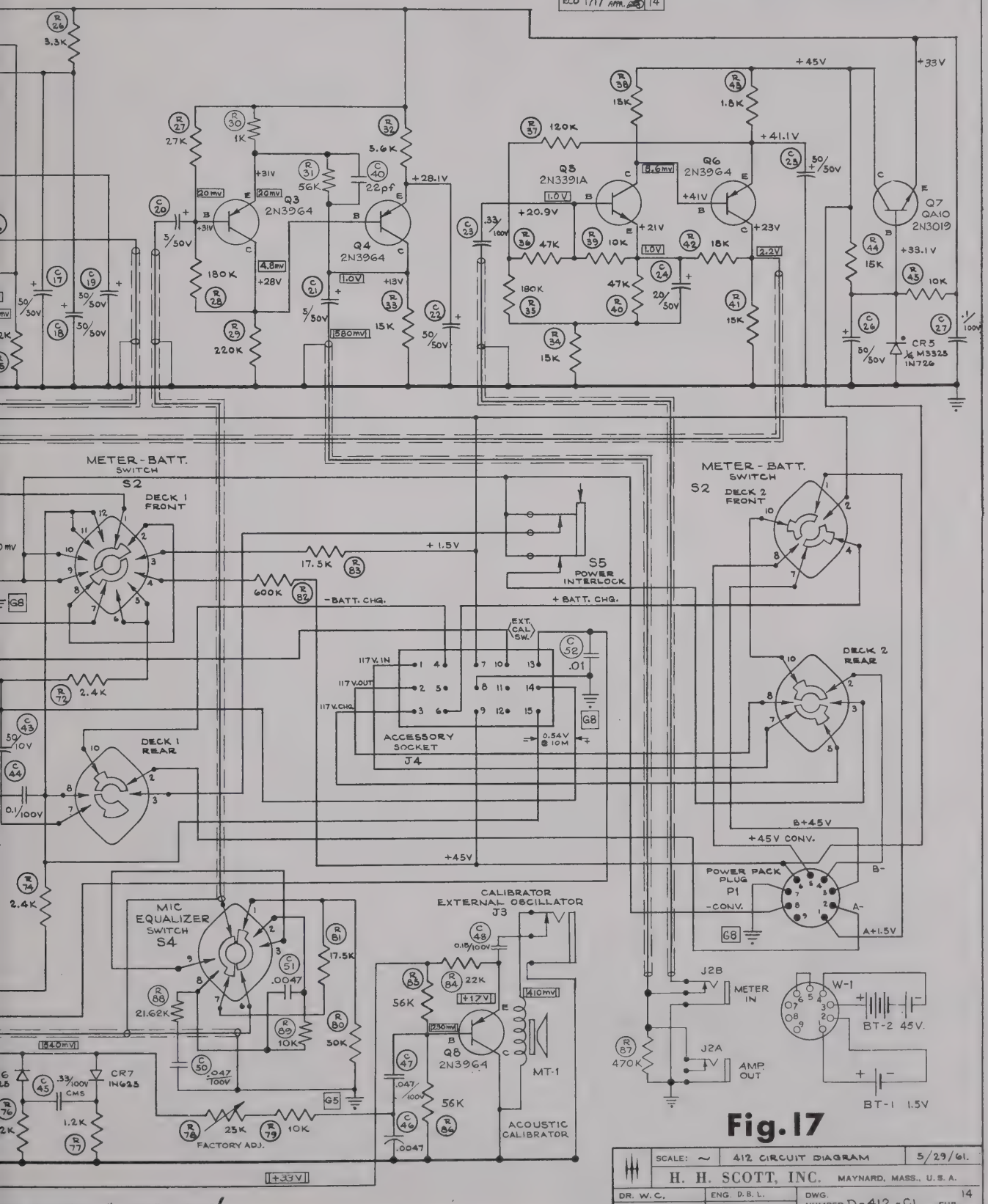


Fig. 17

SCALE: ~	412 CIRCUIT DIAGRAM		5/29/61.
H. H. SCOTT, INC. MAYNARD, MASS., U.S.A.			
DR. W.C.	ENG. D.B.L.	DWG. NUMBER D-412-C1	14
CH.	PROD.		SUB.

IES TO SERIAL # 360115 AND UP!

3. The second calibration system which will make the correction factor always an **even 50 dB** is:

a. Calibrate the 412 with the ceramic microphone as covered in section II.A.2.

b. Choose a broad-band source of noise that is reasonably steady and over 80 db SPL. Note **exact position** of ceramic microphone and take SPL reading of noise in C WEIGHTING – record it. The noise produced by an FM receiver tuned **between stations** is ideal for this comparison, although other noise of fans, etc. may be used if loud enough.

c. Remove ceramic microphone and replace it with the 412X8. Leave 412 in C WEIGHTING position.

d. Place the 412X8 microphone in exactly the same position that the ceramic microphone occupied. With the broad-band source of noise, recalibrate the 412 so the correction factor is 50 dB. This is done by setting the CAL. ADJ. on the 412 Sound Level Meter to obtain the same **meter** reading with the main attenuator set 50 dB **lower** than it was for the ceramic microphone.

e. Make the sound level measurements.

f. Add the 50 dB correction factor to the sound level meter reading to obtain the actual SPL.

g. See B.2.f. above.

4. An alternate electrical calibration procedure is described in the Service and Maintenance Section D.2 for the 412. Use this procedure and proceed as in B.3.e. above.

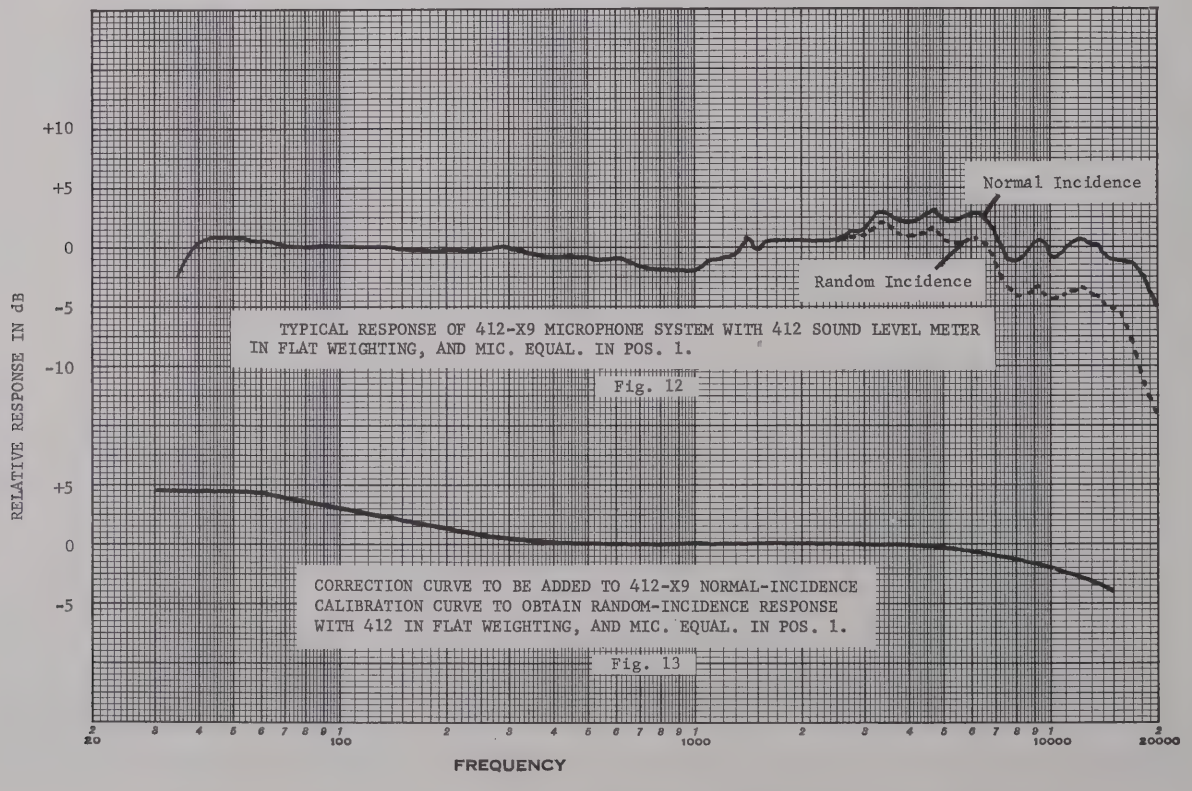
C. 412-X9 Dynamic Microphone System

This is recommended for extremely remote sound level measurements and where a more rugged transducer with higher frequency response may be required. Up to **five** 412X10 100-foot Extension Cables may be used between the Microphone and the input transformer attached to the 412.

The wide uniform frequency response from 35 to 18,000 Hz makes this dynamic microphone one of the most inexpensive microphones that approaches the quality of laboratory standard condenser microphones. With the 412 in the FLAT position the –3 dB points for normal incidence are about 45 Hz and 15 KHz. The polar pattern is omnidirectional in character, approximating that of the standard ceramic microphone. Note that flatest response with this microphone is at **0° Incidence** (head on). The rugged moving coil and mylar diaphragm assure long life. The elements are further protected by sintered bronze filter against contamination of moisture, dirt and dust.

The 412X9 consists of: Specially selected dynamic microphone, "Slip-on" microphone holder with 5/8" –27 thread, tripod adaptor (to mount complete unit

Fig. 12. 412-X9 Typical Frequency Response **Fig. 13. 412-X9 Correction Curve**



on a 412X4 tripod), 15-foot cable, plug-in miniature microphone transformer and calibration curve found on the inside of the wooden storage case. This calibration curve is of the microphone only, at normal incidence. A typical response curve of the 412X9 together with the 412 and its microphone equalizer may be seen in Fig. 12. The correction curve to be added to the microphone response to obtain system (random-incidence) response is shown in Fig. 13.

Operating Instructions:

1. All measurements made with the 412X9 Dynamic Microphone should be done with the MIC. EQUAL switch in position 1. See Service and Maintenance, Section F, Microphone Equalizer for more details.

2. Calibration:

a. Calibrate the 412 with MIC. EQUAL. in STD. and ceramic microphone as covered in II.A.2.

b. Remove the ceramic microphone and insert the transformer housing in its place on the boom. Then connect the microphone cable to the transformer and microphone. Switch MIC. EQUAL. to position 1 (see above). Any 412X10 extension cable(s) go between regular microphone cable and transformer (**never** between transformer and 412 boom).

c. When the 412X9 replaces the original ceramic microphone, the difference in effective sensitivities must be added to the 412 sound level meter reading to obtain the correct sound pressure level. For example, if the ceramic microphone effective sensitivity is –58 dB, and the 412X9 dynamic microphone sensitivity is –60 dB (including transformer), then the correction factor to add to the sound level meter is 2 dB (60-58). If the ceramic microphone effective sensitivity is –61 dB and the dynamic microphone sensitivity is –58 dB, then the correction factor to add to the sound level meter reading is –3 dB (58-61). That is, **subtract** 3 dB from the meter reading. Microphone effective sensitivities are given on the inside back cover of this instruction manual. Check serial #s. Do **not** use open-circuit sensitivity of the ceramic microphone to obtain this correction factor.

d. Take readings with 412 sound level meter and the 412X9 microphone as covered in Sections II.A and II.B. The microphone may be mounted on the 412X4 tripod, any standard 5/8-27 microphone stand, hand-held, or hung.

e. Add the correction factor, determined in (c), to the sound level meter reading to obtain the actual sound pressure level (SPL). (Note: this correction factor may be + or –.)

f. Remember that at high frequencies (above 2.5 KHz) the frequency response varies with angle of incidence of the approaching sound. The response at zero or normal incidence is higher than for random or grazing (90°) incidence, etc. The best overall response is obtained with normal incidence, as shown in Fig. 12. Normal incidence means the microphone points at the source of sound. The flatest response may be approximated with an incidence of 45° but with a loss of response for frequencies above 10 KHz. Random incidence response for the 412X9 Dynamic Microphone corresponds closely to response at about 65° incidence. A correction curve incorporating random incidence correction and equalizer characteristics Pos. 1 is shown in Fig. 13. If this curve is added to the manufacturer's response curve, supplied with the 412X9 microphone, the overall random-incidence response of the 412X9 and 412 (in FLAT pos.) will be obtained.

3. An alternate calibration method which will eliminate the correction factor (make it "0") is described below. This is possible because the sensitivities of the 412X9 microphone and the standard ceramic microphone are comparable within a few dB.

a. Calibrate the 412 with the ceramic microphone as covered in II.A.2.

b. Choose a broad band source of noise that is reasonably steady. (See IV.B.3.b. However, in this case noise need **not** be over 80 dB.) Note **exact position** of ceramic microphone and take SPL reading of noise in C WEIGHTING. Record it.

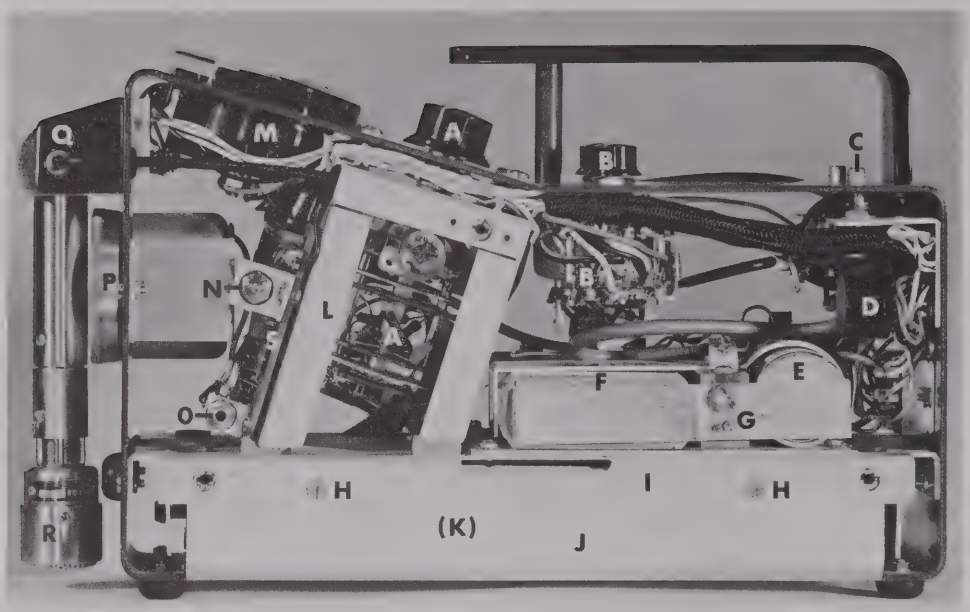
c. Remove ceramic microphone, and plug in the 412X9 microphone system (transformer, cable and mic.). Leave 412 in C WEIGHTING, and switch MIC. EQUAL. to position 1.

d. Place the 412X9 microphone in exactly the same position that the ceramic microphone occupied. With the same broad band steady noise source, recalibrate the 412 so the meter reading is identical. This is done by setting the CAL. ADJ.

4. An alternate electrical calibration procedure is described in the Service and Maintenance, Section D.2.

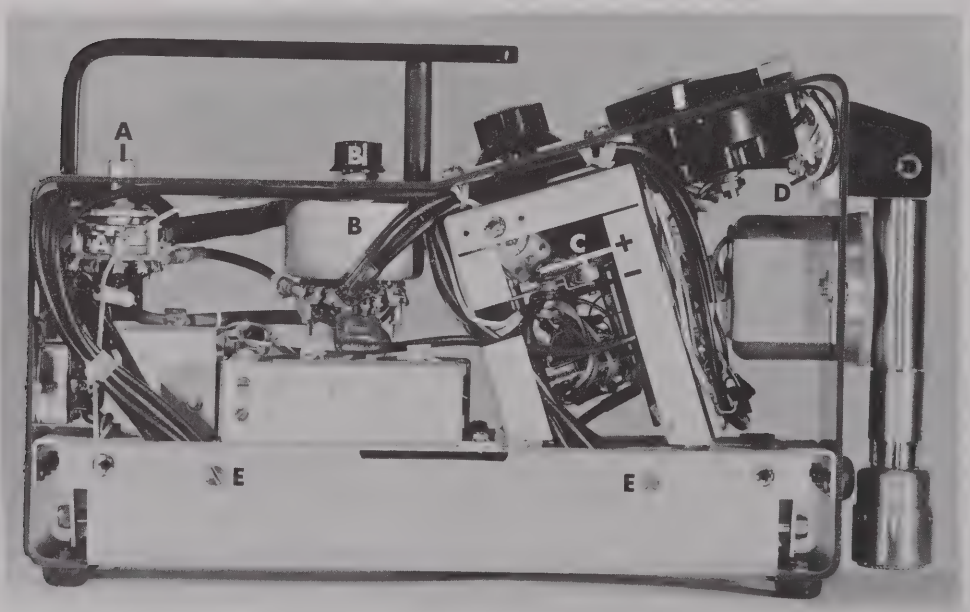
Special Note

The microphone used in the 412X9 System is an Altec 684A microphone especially selected to meet rigid frequency response specifications. We cannot be responsible for the calibration of microphones not purchased from us.



A. Main Attenuator (S1)
B. Meter-Battery Switch (S2)
C. Cal. Adj. (R23)
D. Battery Power Connector (W-1)
E. "A" Battery (BT-1)
F. "B" Battery (BT-2)
G. Battery Clamp
H. Bottom Cover Screws
I. Cross Frame
J. Bottom Cover
K. Main Amplifier Board (Under Cover)
L. Attenuator Shield
M. Meter (MT-1)
N. Calibration Pot. (R78) *FACTORY SET.*
O. External Osc. Jack (J3)
P. Acoustic Calibrator
Q. Microphone Swivel
R. Microphone (MK-1)
S. Meter-Calibrator Circuit Board

Fig. 14. 412 Interior View, Left Side



A. MIC. EQUAL. Switch (S4)
B. WEIGHTING Switch (S3)
C. Bias Cell (BT-3)
D. Power Interlock Switch (S5)
E. Bottom Cover Screws

Fig. 15. 412 Interior View, Right Side

V. Service & Maintenance

A. General

Normally the only service that will be required is changing the batteries and keeping battery contacts clean. If the instrument operates improperly, even with new batteries, preliminary checks may be made and minor difficulties may be repaired with the service information below.

For major difficulties and/or repairs, it is strongly recommended that the instrument be returned to the factory for service and recalibration. If the instrument is to be returned, a complete letter of explanation describing the difficulties should be sent to the Instrument Service Manager. The instrument itself should be very well packed and sent only by prepaid Express, never Parcel Post. It is recommended that you also send this Instruction Manual so our Service Department may correct the calibration figures in it, if necessary.

B. Removal of Covers

1. The left and right side covers are each held on by three ¼ turn fasteners. To remove, turn the fasteners ¼ turn counterclockwise until they snap. The side cover may now be pulled off. When attaching covers, make sure that they are **fully on** the frame before carefully turning the ¼ turn fasteners clockwise until they snap.

2. For removal of the bottom cover, remove both sides and unscrew the four flat-head 6-32 screws on the cross frame. See Figs. 14, 15, Interior Views of 412.

C. Battery Replacement

1. Life of the batteries can be greatly extended by turning the instrument off when not actually making measurements. This is of little inconvenience since it takes less than 15 seconds for the instrument to warm up. With normal use, about 70 hours of battery life can be expected from both batteries. When the 412 will be unused for more than 4 months, it is advisable to remove both of the batteries to avoid possible battery contact contamination from leakage. Alhough the 412 itself may be used in temperatures up to 60°C or 140°F continuously with no ill effect, temperatures in excess of 50°C or 125°F will cause rapid deterioration and possible leakage of the batteries. A temperature of 5°C or 40°F is very desirable for storing batteries.

2. If either battery fails to check up to the meter mark, remove the left side cover of the instrument and the battery clamp (see Fig. 14, Interior View). The battery clamp is removed by turning the thumbscrew (with coin or screwdriver) counterclockwise. Batteries may now be slipped out. BAT 1 is the "A" filament cell, a (round) standard 1½ volt **size D**; BAT 2 is the "B" battery, a (rectangular) **45 volt Eveready 455** or equivalent. Note that the D cell should be installed with plus terminal (nipple) **in** and the B battery with both terminals nearer the **bottom** and the + terminal to the **left.** When inserting the batteries, it is advisable to have the instrument on (mic. boom up) and the METER switch at BAT 2. Thus, you will know when the B battery is hitting the contracts from a correct meter indication. Once the battery clamp has been firmly screwed down, you can check BAT 1 for proper contacts. For your convenience, since the useful life of the batteries is nearly equal, we suggest both batteries be replaced at the same time.

3. The silver bias cell, Eveready 303, has been selected for long life and should last at least 2 years with typical usage. It may be reached by removing the **right** side cover of the instrument. The bias cell is located in the forward, upper right hand corner of the attenuator shield, on a small angle bracket. See Fig. 15. The bias cell may be checked with a standard voltmeter of 20,000 ohms per volt or above. Readings of less than 1.4 volts indicate need for replacement. The cell may be most easily removed with long-nose pliers. The + side of the bias cell goes **up** (note that the **shell** is + and the smaller insulated button is –). The 303 cell is used in Timex and other electric watches; replacements may be obtained wherever these are sold, or from H. H. Scott, Inc., Part BT-303. The 303 cell is also known as **EXP-77,** which is available at photographic stores.

D. Calibration and Sensitivity

1. Acoustical Calibration

a. In addition to the electro-acoustic calibration described in the Operating Instructions, the 412 may also be calibrated from an external 600 ohm oscillator. To reach the External Oscillator Jack J3, remove the **left** side cover. The jack is located behind the acoustic calibrator housing (see Fig. 14, Interior View of 412) on the printed circuit board. This jack will accept a Switchcraft Type 780 Tini Plug or equivalent. Plugging a 600 ohm oscillator into this jack disconnects the Acoustic Calibrator from the calibrating circuit. See Fig. 17, 412 Circuit Diagram.

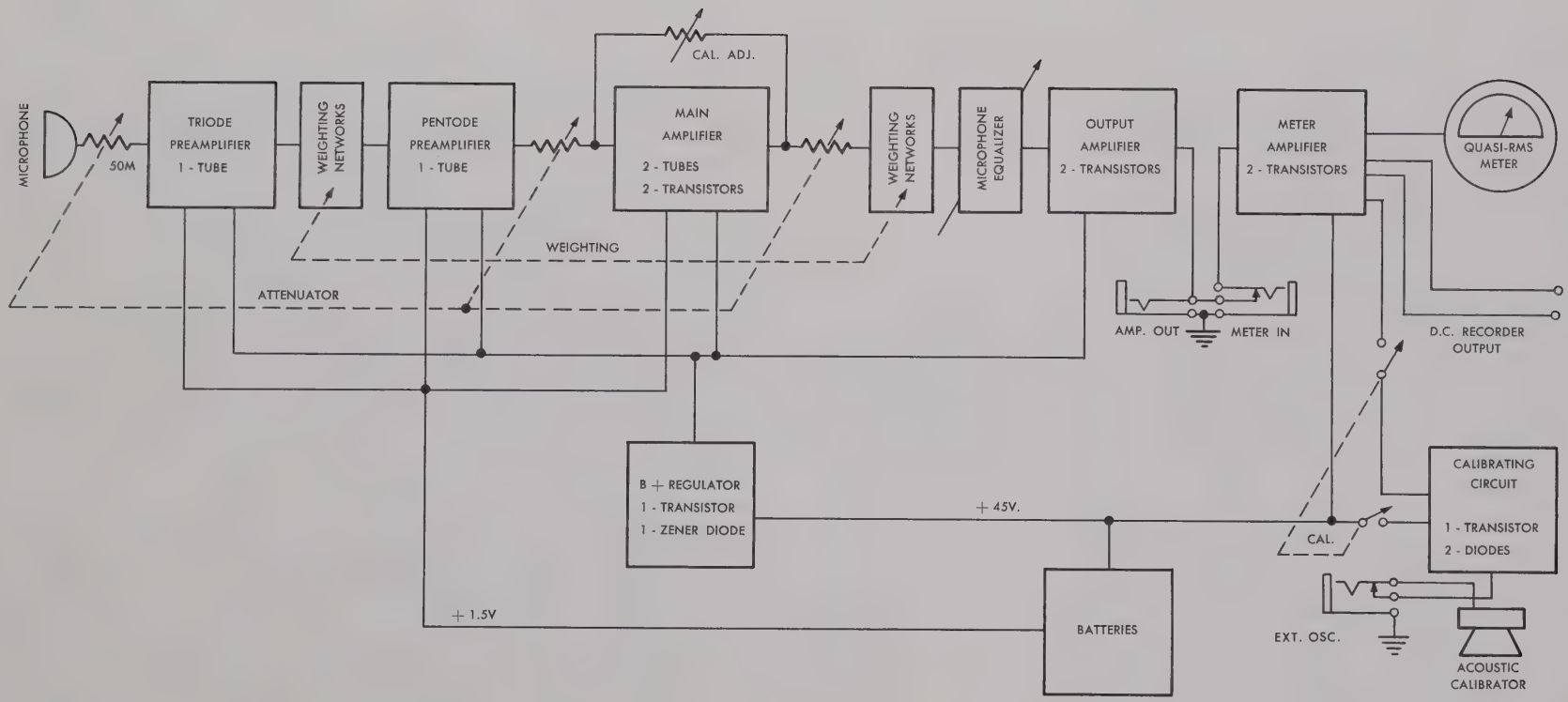


Fig. 16. 412 Block Diagram

b. Set up the 412 as in the Electro-acoustic Calibration Section II.A.2. in this manual. Plug the oscillator into the External Oscillator Jack. Accurately adjust the oscillator to the frequencies and voltages given in the back of this manual and set the CAL. ADJ. control to obtain a meter reading of 106 dB SPL. The 412 is now calibrated. If the 412 calibrates properly this way and doesn't in the normal fashion, the calibrating circuit or associated switches might not be working properly. Do not touch the miniature potentiometer on the small printed circuit Calibrator Board; it is factory adjusted.

2. Electrical Calibration

a. Given the sensitivity of the ceramic microphone supplied with the 412, or for any of the accessory microphones, the Sound Level Meter may be electrically calibrated with a low impedance (600 ohm) audio oscillator and an accurate AC voltmeter. Electrical calibration assumes the microphones to be in good condition.

b. The standard ceramic microphone represents a capacitive source of about 450 pf. When this is connected to the input of the 412, which has a shunt capacitance of about 60 pf, a capacitive voltage divider is formed; this **lowers** the effective output of the microphone by the ratio of the capacitances, or 1.3 dB. Thus the **effective sensitivity** of the microphone is 1.3 dB lower than its **open-circuit** sensitivity (as supplied by the manufacturer or as measured by the reciprocity method). It is this **effective sensitivity** which is used to calibrate the 412 with an external oscillator.

c. The situation is somewhat different with the 412X8 and 412X9 microphones. While the source impedance of the 412X8 is also 450-500 pf, it is calibrated for –106 dB sensitivity **when connected to the 412 input** (**not** open circuit). Thus the –106 dB **is** the effective sensitivity; no open circuit sensitivity is given or needed. The 412X9, on the other hand, is not a capacitive source at all (it is essentially resistive at mid-frequencies) and the 60 pf input capacitance of the 412 has no appreciable effect on its sensitivity. Thus its open circuit sensitivity and effective sensitivity connected to the 412 are identical.

d. To calibrate the 412 using an external oscillator, connect the equipment as shown in Fig. 18. Adjust the oscillator to 1000 Hz and oscillator output level to exactly 1.0 v. RMS. The WEIGHTING switch on the 412 should be on C; MIC. EQUAL.

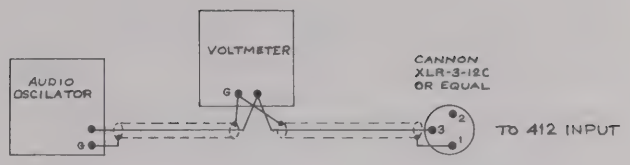


Fig. 18. 412 Electrical Calibration

on STD. for ceramic or 412X8 microphones, on position 1 for 412X9. The 412 should read as shown in the following chart; if it does not, adjust the CAL. ADJ. control.

Microphone Type	Effective Microphone Sensitivity dB re: 1 volt/microbar	412 Sound Level Meter Reading in dB with 1 volt RMS input	Correction Factor: Add to 412 Reading for actual SPL in dB
412X8	–106 (std.)	130	50
	–62	136	0
	–61	135	0
Standard	–60	134	0
Ceramic	–59	133	0
or	–58	132	0
412X9	–57	131	0
	–56	130	0
	–55	129	0

e. If the 412 calibrates properly this way, but not as in section V.D.1, the acoustic calibrator, microphone or associated cables and connectors are not working properly.

Note: Interpolate for sensitivities between the figures in the chart. For example, if microphone sensitivity is –59.8 dB, 412 reading should be 133.8 dB.

3. Sensitivity for Decade Amplifier or Voltmeter Use

a. To calibrate the 412 Sound Level Meter as a decade amplifier or voltmeter, use the same cable and instrument setup as that used for electrical calibration for the 412X9 Dynamic Microphone, Section V.D.2.d.

b. For **decade amplifier** use, the MIC. EQUAL. control should be in STD. position, WEIGHTING in C or FLAT, and Main Attenuator on 120 dB. Adjust the oscillator to 1000 Hz and 1 volt RMS output. Plug the AC voltmeter into the AMP. OUT jack of the 412. With the CAL. ADJ. set 412 output voltage to 1 volt RMS. The Sound Level Meter now has a voltage gain of exactly 1

on the 120 dB scale. (The 412 meter will probably indicate about 1 dB above full-scale deflection but with an additional 10 dB overload, this should be of no concern.) Thus, with a Main Attenuator setting of 100 db, the 412 will have a voltage gain of 20 dB (120-100) or ten times; with a 70 dB setting, the gain will be 50 dB (120-70) or 316 times. (Alternately, the 412 can be adjusted for a voltage gain of 1 with Main Attenuator on 130 dB, but the MIC. EQUAL. may have to be in position 2 for extra gain.)

c. For **voltmeter** use, you may use procedure D.3.b. with the external AC voltmeter or the following procedure, using the meter on the 412. Set MIC. EQUAL. to STD., WEIGHTING to C or FLAT and Main Attenuator to 130 dB. Adjust oscillator to 1000 Hz and 1 volt RMS output. With CAL. ADJ. set meter reading on 412 to "0" dB. Thus, 130 dB corresponds to 1 volt RMS, 100 dB to 316 millivolts RMS, and 50 dB to 100 microvolts.

d. Using the 412 in the above manner as a decade amplifier and voltmeter is based on the relationship:

$$\text{Voltage Gain in dB} = 20 \text{ Log}_{10} \frac{\text{E out}}{\text{E in}}$$

After using 412 in this fashion, don't forget to recalibrate the instrument for sound measurements.

E. Internal Noise

1. With a properly operating 412, internal noise should not affect readings for attenuator settings of 40 dB or above. The internal noise may be checked and compared with the chart under 412 specifications in the front of this manual. First wire up a dummy microphone. Connect a 470 pf capacitor between pins 1 and 3 of a Cannon XLR-3-12c plug and a ground wire from pin 1 to under the cable clamp on the shell of the plug. The capacitor **must** be well shielded. Replace the ceramic microphone with this dummy microphone and make the measurements with an analyzer or a sensitive AC voltmeter from the 412 AMP. OUT jack.

2. High internal noise may be caused by; the bias cell; low batteries; zener diode D5; V1; V2 or V3. The tubes can be checked out by exchanging them. **Note:** The CK512AX tubes are picked at the factory for low noise and low microphonics. See 412 Component Layout Fig. 19. The best tubes are used as V1.

F. Microphone Equalizer Switch

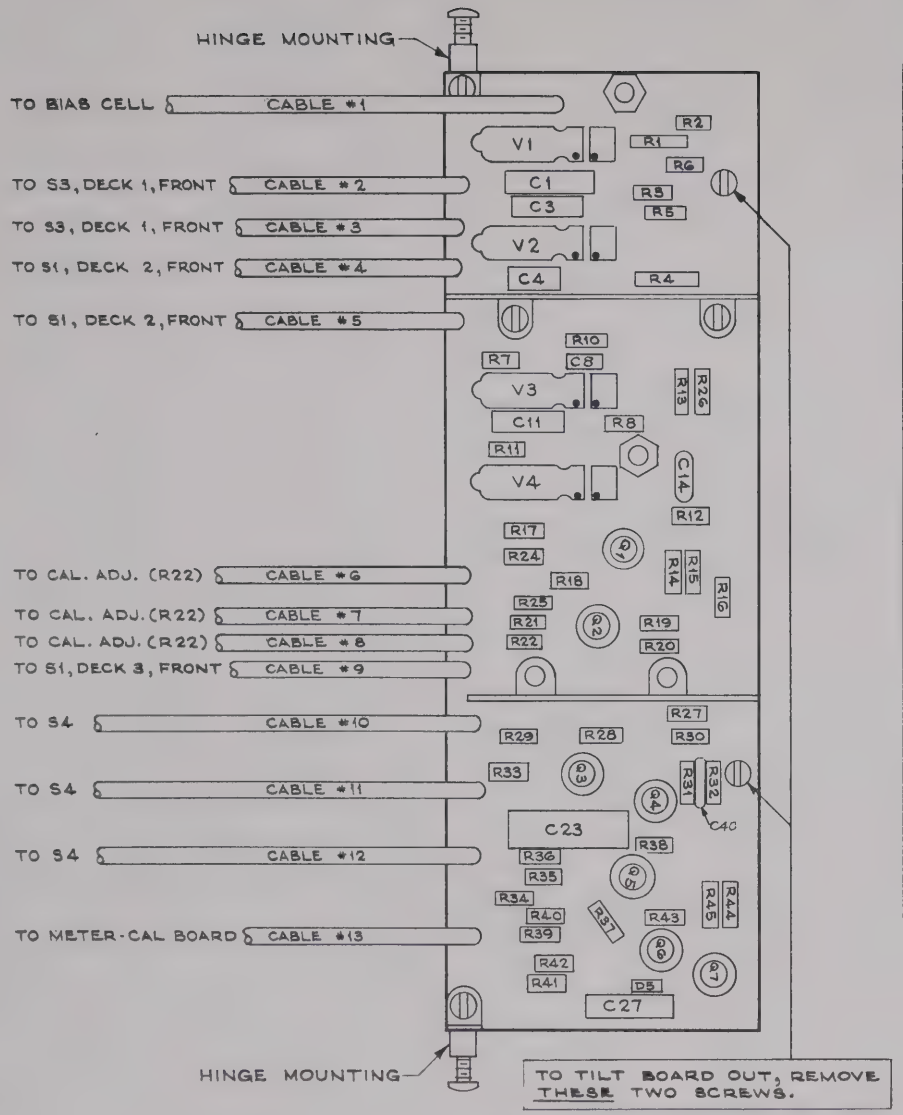
1. This equalizer is used in the STD. position for the ceramic microphone and for some of the accessory microphones. Since the combined frequency response of some accessory microphones and the 412 Sound Level Meter falls outside the tolerance of the ASA S1.6-1961 requirements, provision for special equalization has been incorporated in the 412. The frequency response of the 412X9 Dynamic Microphone deviates from the ASA requirements from around 200 Hz down and from 5 KHz up. An equalizer network is selected by the MIC. EQUAL. switch S4 in position 1 to bring the frequency response of the complete system (at random incidence) within ASA requirements.

2. Position 2 is provided for future networks for other microphones. As wired at the Factory, no equalization is provided in position 2 — it is wired "straight-through" with a green jumper wire and provides the same response and about 5 dB extra gain compared to the STD. position.

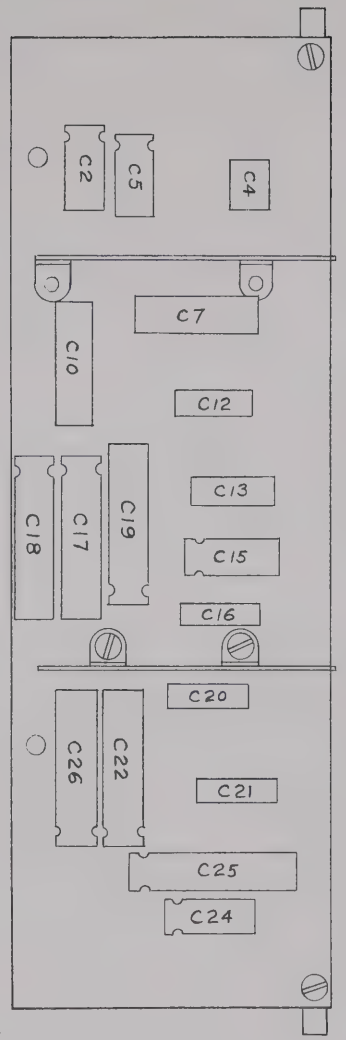
G. Access to Printed Circuit Boards

1. The small printed circuit Calibrator Board is reached by removal of the left and right side covers. It is located directly below the meter. If it is necessary to reach the rear of the Calibrator Board, the four screws on the corners should be removed. Do not lose the four fiber washers and fish paper, for these prevent shorting out the board. The fish paper goes against the attenuator shield and the fiber washers between the paper and the board. If greater access to this board is necessary, remove the Acoustic Calibrator and then remove the two mounting screws for the Acoustic Calibrator Housing, and carefully slip it out.

2. The shock-mounted large printed circuit Main Amplifier Board is located below the cross frame. It is reached by removing the left and right covers and unscrewing the four flat-head screws for the bottom cover. This will give access to the transistors, but not the tubes. (For ease of interpreting instructions, place the microphone end of the Sound Level Meter to your left and lay the 412 on its right side.) The tubes are clamped between foam pads by the aluminum bracket on the left side of the Main Amplifier Board. Remove the bracket by unscrewing the two screws on its surface. The rear of the Main Amplifier Board is easily reached by removing the two screws on the upper edge of the board, see Fig. 19, 412 Component Layout. The complete Main Amplifier Board may now be hinged open. The pivots are at the bottom of the Board.



MAIN AMPLIFIER CIRCUIT BOARD AS VIEWED WITH BOTTOM COVER REMOVED.



BACK SIDE

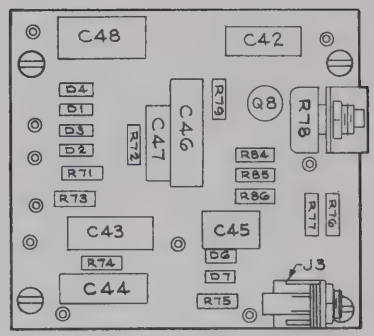
TUBE TYPES

NOTE: ALL TUBES ARE SELECTED FOR OPTIMUM PERFORMANCE IN EACH STAGE. ORDER SPARES OR REPLACEMENTS BY LETTER (A, B, etc.)

V1	CK-512-AX-A
V2	CK-512-AX-C
V3	CK-512-AX-B
V4	CK-512-AX-D

TRANSISTORS

Q1, Q5	2N3391A
Q2, Q3, Q4, Q6, Q8	2N3964
Q7	2N3019 (QA-10)



CALIBRATOR CIRCUIT BOARD

Fig. 19. 412 Component Layout

H. Circuit Diagram & Location of Parts and Test Voltages

1. To aid in understanding the 412 Circuit Diagram Fig. 17, refer to Fig. 16, 412 Block Diagram. At the same time, to assist in locating parts, open up and position the 412 as in V.G.2., and refer to Fig. 14, Interior View of 412. The complete Sound Level Meter can be divided into operational sections. The unit has physically been laid out in these sections. The Main Amplifier Board is divided up by the small vertical shields on it.

a. **Attenuator Switch S1.** The three decks of the attenuator switch are distributed through the amplifier to maintain a high signal-to-noise ratio and dynamic range. S1 is located in the Attenuator Shield. Placement of components is extremely critical.

b. **WEIGHTING Switch S3.** The two decks of the WEIGHTING network switch have also been distributed through the amplifier. Deck 1 of S3 is inside the cup shield and Deck 2 is in the open. There should be little need of ever opening up the shield. The shielding on wires to Deck 1 **must** end inside the cup shield.

c. **METER Swith S2.** This unshielded switch has two decks. Deck 1 and Deck 2 (front) control battery circuits and Deck 2 (rear) controls the Quasi-RMS Meter Circuit.

d. **Preamplifier.** The preamplifier is located on the left of the large Main Amplifier Board. The Preamp consists of: Deck 1 of S1, V1 triode preamplifier tube, Deck 1 of S3, and V2 pentode preamplifier tube. At 1000 Hz in C WEIGHTING, voltage gain is about 36 dB, with S1 set at 80 dB.

e. **Main Amplifier.** The Main Amplifier is located in the center of the large Main Amplifier Board. The Main Amplifier consists of: Deck 2 of S1, V3 and V4 triode amplifier tubes, Q-1 emitter-follower transistor, Q2 transistor amplifier, and R23 the CAL. ADJ. potentiometer, which controls the negative feedback around the Main Amplifier.

f. **Output Amplifier.** This is located on the right of the large Main Amplifier Board. The Output Amplifier consists of: Deck 3 (front) of S1; Deck 2 (front) of S3, S4 the MIC. EQUAL., Q3 transistor, Q4 transistor, and J2A, the AMP. OUT jack. Closed-loop gain for Q3 and Q4 alone is about 34 dB and open loop (R31 removed) above 50 dB.

g. **Meter Amplifier.** It is located on the far right of the large Main Amplifier Board. The meter Amplifier consists of: J2B METER IN jack, Q5 transistor, and Q6 transistor. Closed loop gain is 6.5 dB. Extreme care should be taken not to short the output of Q6 for it will burn up instantly.

h. **B+ Regulator.** Located in the upper right corner of the large Main Amplifier Board is the B+ Regulator consisting of: Q7 transistor emitter-follower and D3, a 33 volt Zener diode.

i. **Quasi-RMS Meter Circuit.** This circuit is located on the small Calibrator Board below the meter. It consists of: C25, D1 through D4, R71 through R74, C43, C44, and the meter. Associated with the meter circuit is the DC output for direct writing recorder. This is available from pins 14 (+) and 15 (–) on the 15 Prong Accessory Receptacle J4. See Introduction Section I.B.1.d. and Fig. 17, 412 Circuit Diagram.

j. **Calibrating Circuit.** The Calibrating Circuit is located on the small Calibrator Board. It consists of: Q8 transistor, D6, D7, R75 through R79, R84 through R86, and C45 through C48. R78 is factory adjusted. **Do not attempt to adjust R78** without the proper instructions from the factory and a Laboratory Standard Microphone System. R78 determines the calibration of the 412.

k. **Test Voltages.** All normal voltages are indicated on the 412 Circuit Diagram Fig. 17 and are measured with a VTVM. DC voltages have a + beside them and AC voltages are in a rectangle. See Voltage Code at top of Fig. 17 for complete explanation.

I. Tube & Transistor Replacement

1. See Fig. 17, 412 Component Layout. When replacing a tube, cut the leads on the new one to ¼ inch before plugging in. Great care should be used when inserting. The red dot on the tube is placed on the right and opposite the red dot on the socket. Tubes are selected for specific characteristics of noise, etc. at the factory. Order for a specific circuit position (V1, V2, etc.).

2. When replacing a transistor with a new one, cut the leads to 3/16 inch long and plug in. Q8 can easily be re-inserted with tweezers or longnose pliers. Transistors with in-line leads should be pre-formed to the triangular configuration as shown in the upper left corner of Fig. 17.

J. Soldering Wires and Cables

1. The plastic insulation on many of the wires and cables will melt very easily. Heat can be carried away with pliers on the wire near the area you are soldering. Avoid excessive heat and solder. Use only pure rosin-core solder. Acid-core solder can cause serious deterioration of insulation resistance, and even ultimate corrosion and failure of the wire itself.

Accessories — Maintenance

K. 412X1 Leather Case

1. Normal use of saddle soap for cleaning and wax for waterproofing. Do not store under high humidity or it may mildew.

L. 412X2 Calibration Curve

1. Keep this curve in its plastic folder to avoid excessive handling damage. It is suggested that a copy be made for field use. If it is ever necessary to return your 412 to the Factory, **return this curve with it.**

M. 412X3 Extension Cable and Tripod Adaptor

1. Coil properly when not using and avoid kinking.
2. If repair is necessary see Section V.J.
3. Do not expose to temperatures above 85°C or 185°F.

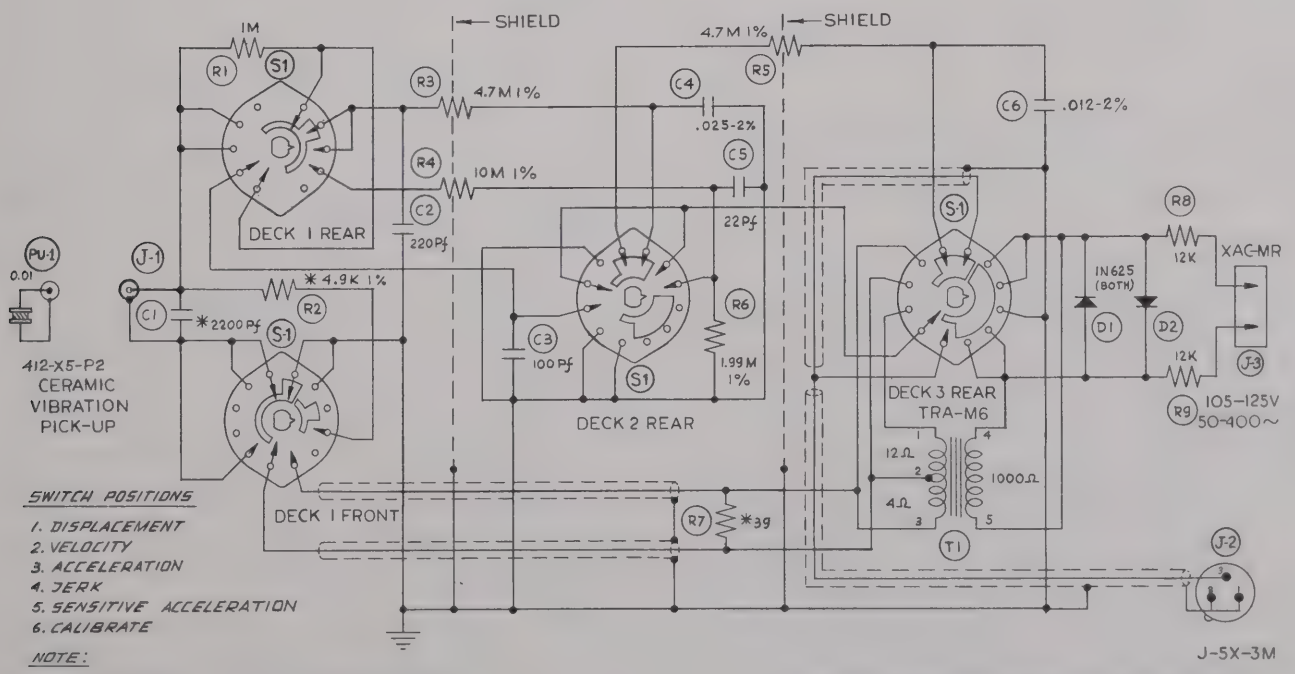
N. 412X4 Tripod and Case

1. Keep tripod clean and oil occasionally. Do not over-tighten tilt lock. Case remains on the tripod in use — no need to remove it.

O. 412X5 and 412X5A Vibration Accessories

1. Removal of cover is accomplished by: removing knob, unscrewing the 3/8 inch nut and lifting off the cover.
2. The 412X5 Vibration Accessory Circuit Diagram is Fig. 20. The shields have been placed on the diagram to agree with the physical layout of the Integrator. Deck 1 of the switch is at the top of the unit (near the knob). The 412X5A circuit is shown in Fig. 21.
3. Component placement in both units is extremely critical; do not change location of components.
4. If repairs are required, see Section J in Service and Maintenance.
5. Do not expose to temperatures above 75°C or 165°F.
6. Leather case with the 412X5A — see Section V.K.

Fig. 20. 412-X5 Circuit Diagram



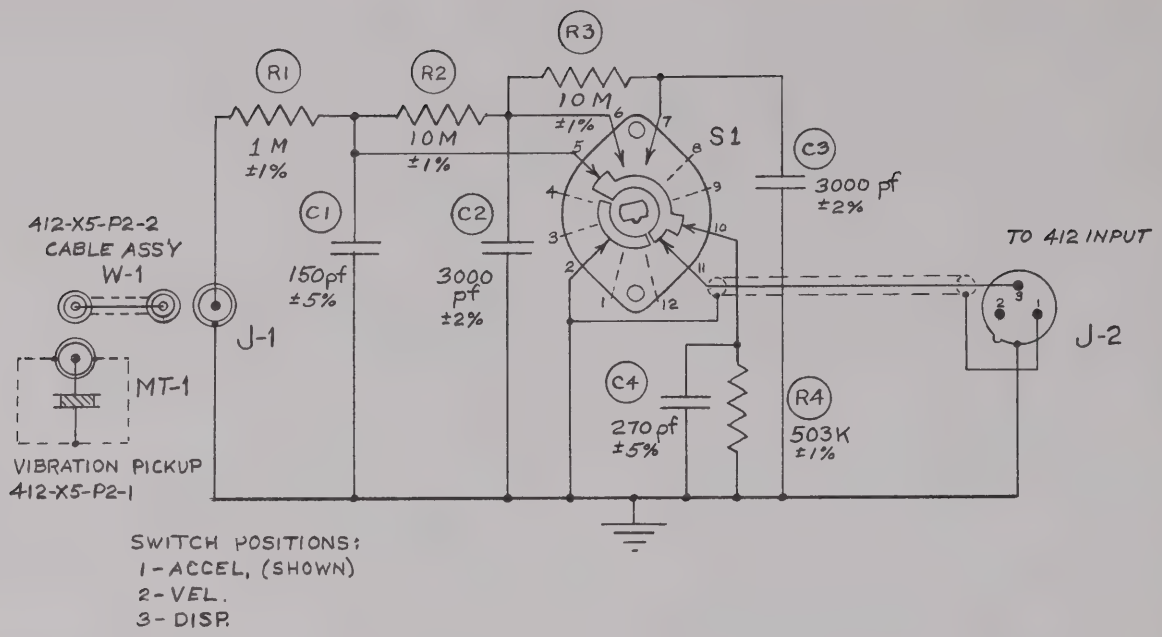


Fig. 21. 412-X5A Circuit Diagram

P. 412X8 Wide Range Microphone

1. Avoid excessive kinking of cable and dropping of microphone.

2. Do not expose to temperatures above 70°C or 160°F.

3. See Service and Maintenance Section V.D.2.b. for electrical calibration.

4. Never alter the length of the 412X8 cable or calibration will be off.

5. If unable to calibrate, return to factory for service.

Q. 412X9 Dynamic Microphone System

1. Do not expose to temperatures above 70°C or 160°F.

2. See Service and Maintenance Section V.D.2.c. for electrical calibration. Note again that the transformer must mount **on the 412 microphone boom** — no added cable between.

3. Schematic for the 412-X9 System is Fig. 22. In case of difficulty check the microphone and the transformer for continuity using the ohmmeter. The microphone should measure about 10 ohms, the primary of the transformer about 35 ohms, and the secondary about 6000 ohms. If these resistances do not check, then the wires may have come loose, or the windings may have opened. It is suggested that the unit be sent back to the factory for repair. However, if the transformer must be removed from the case, it can only be accomplished through the secondary or the 412 end. First remove the screw on this end. **Pull out** the connector insert, unsolder ground wire from shell, and **then** unscrew the connector shell. The transformer may now be **gently** removed.

4. The 412X9 dynamic microphone (an Altec 684A specially selected for frequency response) comes from the factory wired for 150/200 ohms, or the white wire in the microphone connector, XLR-5-11C, on pin 4. (For 30/50 ohms, the white wire goes onto pin 3 and for 20,000 ohms onto pin 5.)

5. If unable to calibrate or if unit doesn't work, return to the factory for repair and calibration.

R. 412X10 100-foot Extension Cable

Avoid excessive kinking when coiling. Keep connector contacts free of dirt.

S. 412X12 AC Power Supply

1. Removal of side covers is accomplished in the same manner as for the 412, Section V.B.1.

2. If the pilot light does not go on, a blown fuse may be the problem. This may be caused by:

a. Accidental short across the male 15 prong plug on the 412X12; or

b. Circuit troubles within the 412X12 or wire and switch problems in the 412.

Before replacing the fuse, determine and remedy the cause of failure. The fuse is a 1/16 amp slo-blo type 3AG or MDL 1/16. It is rather delicate and can be open-circuited by mechanical shock.

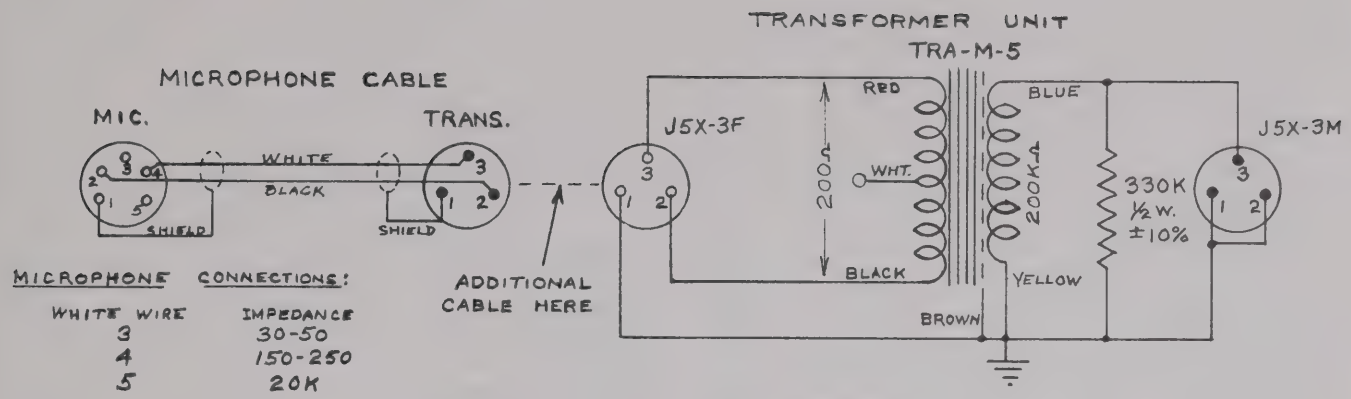


Fig. 22. 412-X9 Circuit Diagram

3. Excessive noise in the 412 Sound Level Meter (see Service and Maintenance Section E) can be caused by high ripple on the supply voltages from the 412X12. Equivalent SPL 412 noise should be under 30 dB, when checked with a dummy microphone – Section V.E.1.

a. The regulated +1.3 volt @ 40 milliampere supply should have about 30 microvolts RMS ripple or less.

b. The regulated +45 volt supply should have about 350 microvolts RMS ripple or less. Excessive supply ripple and/or noise can be caused by faulty capacitors, transistors, diodes, incorrect grounding (ground loops) or incorrect polarity on the power plug.

4. For instructions on replacement of transistors, see Section V.I.2.

5. Test voltages and currents may be seen on Fig. 23, 412X12 Circuit Diagram. DC voltages are preceded by + or – and AC voltages are in rectangles. Parts may be located by referring to Fig. 24, 412X12 Component Layout.

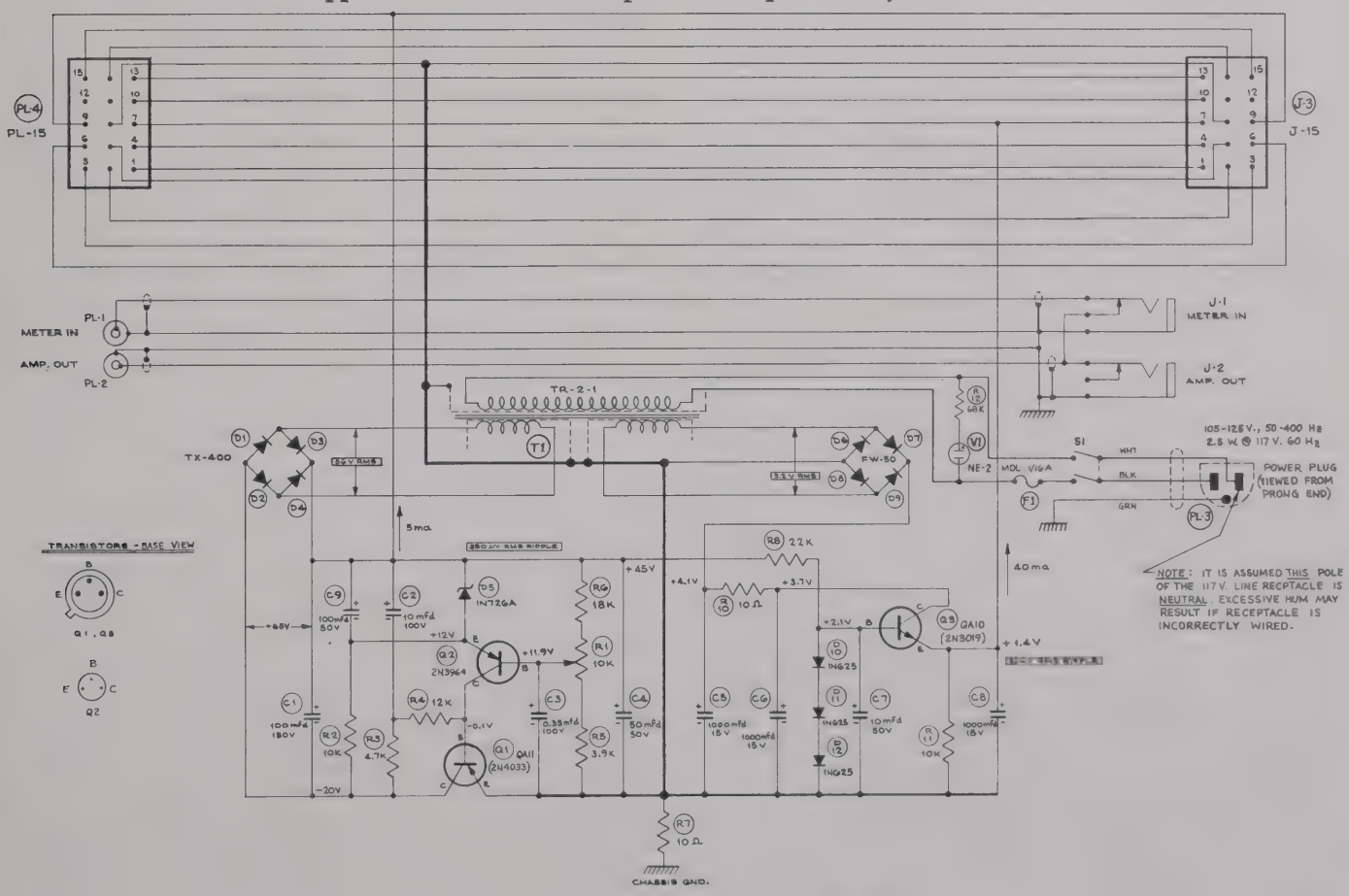


Fig. 23. 412-X12 Circuit Diagram

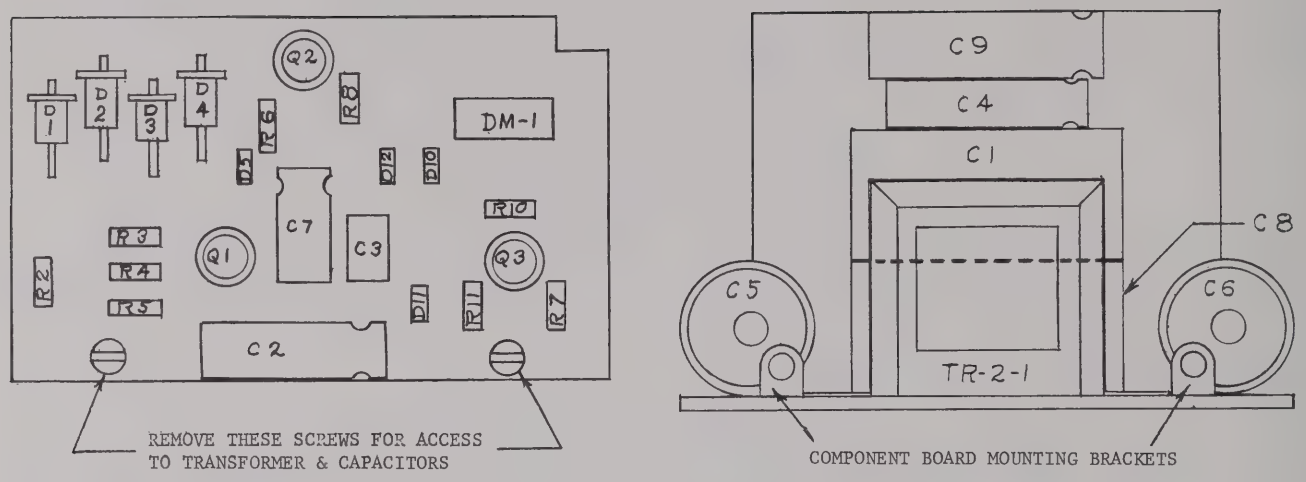


Fig. 24. 412-X12 Component Layout

VI. Parts Lists

A. Sound Level Meter

Circuit Reference	*Description*	*HHS Part No.*
BT-1	Battery, 1.5v. (Eveready 950 or equal)	BT-1-D
BT-2	Battery, 45v. (Eveready 455 or equal)	BT-30-45
BT-3	Cell, bias (Eveready 303, EPX-77 or equal)	BT-303
C1	Capacitor, 1.0 mfd. @ 100v.	CPS-1.0
C2	Capacitor, 10 mfd. @ 50v. elect.	CETM-10/50
C3	Capacitor, .047 mfd. @ 100v.	CPS-.047
C4	Capacitor, .33 mfd. @ 100v.	CMS-.33/100
C5	Capacitor, 20 mfd. @ 50v. elect.	CETM-20/50
C6	Capacitor, .33 mfd. @ 100v.	CMS-.33/100
C7	Capacitor, .33 mfd. @ 100v.	CPS-.33/100
C8	Capacitor, 4.7 pf. ceramic	CC-4.7
C9	Not used	
C10	Capacitor, .33 mfd. @ 100v.	CPS-.33/100
C11	Capacitor, .047 mfd. @ 100v.	CPS-.047
C12	Capacitor, 5 mfd. @ 50v. elect.	CETM-5/50
C13	Capacitor, 5 mfd. @ 50v. elect.	CETM-5/50
C14	Capacitor, 47 pf. mica	CM15-47
C15	Capacitor, 10 mfd. @ 50v. elect.	CETM-10/50
C16	Capacitor, 5 mfd. @ 50v. elect.	CETM-5/50
C17	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50
C18	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50
C19	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50
C20	Capacitor, 5 mfd. @ 50v. elect.	CETM-5/50
C21	Capacitor. 5 mfd. @ 50v. elect.	CETM-5/50
C22	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50
C23	Capacitor, .33 mfd. @ 100v.	CPS-.33/100
C24	Capacitor, 20 mfd. @ 50v. elect.	CETM-20/50
C25	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50

Circuit Reference	Description	HHS Part No.
C26	Capacitor, 50 mfd. @ 50v. elect.	CETM-50/50
C27	Capacitor, 1.0 mfd. @ 100v.	CPS-1.0
C28	Capacitor, 12 pf. trimmer	CCV-12
C29	Capacitor, 7 pf. trimmer	CCV-7
C30	Capacitor, 15 pf. ceramic NPO	CC-15-NPO
C31	Capacitor, 499 pf. 2% mica	CM15-499-2
C32	Capacitor, 499 pf. 2% mica	CM15-499-2
C33	Capacitor, 499 pf. 2% mica	CM15-499-2
C34	Capacitor, 1500 pf. 5% mica	CM20-1500-5
C35	Capacitor, 5600 pf. 2% mica	CM30-5600-2
C36	Capacitor, 33 pf. mica	CM15-33
C37	Capacitor, 5600 pf. 2% mica	CM30-5600-2
C38	Capacitor, 3.3 pf. ceramic	CC-3.3
C39	Capacitor, 62 pf. mica	CM15-62
C40	Capacitor, 22 pf. mica	CM15-22
C41	Capacitor, 820 pf. mica	CM20-820
C42	Capacitor, 5 mfd. @ 50v. elect.	CETM-5/50
C43	Capacitor, 50 mfd. @ 10v. elect.	CETM-50/10
C44	Capacitor, 1.0 mfd. @ 100v.	CPS-1.0
C45	Capacitor, .33 mfd. @ 100v.	CMS-.33/100
C46	Capacitor, .0047 mfd. @ 400v.	CPM-.0047
C47	Capacitor, .047 mfd. @ 100v.	CPS-.047
C48	Capacitor, .15 mfd. @ 100v.	CPS-.15
C49	Capacitor, 1000 pf. 2% mica	CM20-1000-2
C50	Capacitor, .047 mfd. @ 100v.	CPS-.047
C51	Capacitor, .0047 ceramic disc	CC-.0047
C52	Capacitor, .01 ceramic disc	CC-.01
CR1-4	Diode, 1N294 (4)	D-1N294
CR5	Diode, 1N973A	D-1N973A
CR6,7	Diode, 1N625	D-1N625
J-1	Connector, microphone	J-5X-3F
J-2 (A+B)	Jack, dual phone plug	J-3-D
J-3	Jack, miniature	J-8-3
J-4	Connector, accessory	J-15
M-1	Meter, indicating	M-DB-3
MK-1	Microphone assembly	MK-C-1
MT-1	Transducer, calibrator	MK-R-1
P-1	Connector, battery	PL-9
Q1,Q5	Transistor, 2N3391A	QA-12
Q2,3,4,6,8	Transistor, 2N3964	Q-2N3964
Q7	Transistor, 2N3019	QA-10
R1	Resistor, 100K, 5%	RP-100K-5
R2	Resistor, 330K	RC21-330K
R3	Resistor, 10 Meg	RC21-10M
R4	Resistor, 162K, 1%	RP-162K-1
R5	Resistor, 1 Meg	RC21-1M
R6	Resistor, 47K	RC21-47K
R7	Resistor, 22 Meg	RC21-22M
R8	Resistor, 270K	RC21-270K
R9	Not used	
R10	Resistor, 220K	RC21-220K
R11	Resistor, 10 Meg	RC21-10M
R12	Resistor, 68K	RC21-68K
R13	Resistor, 100K	RC21-100K
R14	Resistor, 47K	RC21-47K
R15	Resistor, 27K	RC21-27K
R16	Resistor, 39K	RC21-39K
R17	Resistor, 100K	RC21-100K
R18	Resistor, 150K	RC21-150K
R19	Resistor, 15K	RC21-15K
R20	Resistor, 5.6K	RC21-5.6K
R21	Resistor, 27K	RC21-27K
R22	Resistor, 27K	RC21-27K
R23	Resistor, variable, 5K	RCV-5K
R24	Resistor, 1.0K	RC21-1K
R25	Resistor, 2.2K	RC21-2.2K
R26	Resistor, 3.3K	RC21-3.3K
R27	Resistor, 27K	RC21-27K
R28	Resistor, 180K	RC21-180K
R29	Resistor, 220K	RC21-220K
R30	Resistor, 1.0K	RC21-1K
R31	Resistor, 56K	RC21-56K
R32	Resistor, 5.6K	RC21-5.6K
R33	Resistor, 15K	RC21-15K
R34	Resistor, 15K	RC21-15K
R35	Resistor, 2.2K	RC21-2.2K
R36	Resistor, 47K	RC21-47K
R37	Resistor, 220K	RC21-220K
R38	Resistor, 15K	RC21-15K
R39	Resistor, 10K	RC21-10K
R40	Resistor, 47K	RC21-47K
R41	Resistor, 15K	RC21-15K
R42	Resistor, 18K	RC21-18K
R43	Resistor, 1.8K	RC21-1.8K
R44	Resistor, 15K	RC21-15K
R45	Resistor, 10K	RC21-10K
R46	Resistor, 50 Meg, 1%	RP-50M-1
R47	Resistor, 5.55 Meg, 1%	RP-5.55M-1
R48	Resistor, 555K, 1%	RP-555K-1
R49	Resistor, 22 Meg	RC21-22M
R50	Resistor, 1.54 Meg, 1%	RP-1.54M-1
R51	Resistor, 600K, 1%	RP-600K-1
R52	Resistor, 1.0 Meg, 1%	RP-1M-1
R53	Resistor, 1.0 Meg, 1%	RP-1M-1
R54	Resistor, 50.5K, 1%	RP-50.5K-1
R55	Resistor, 98.9K, 1%	RP-98.9K-1
R56	Resistor, 683.8K, 1%	RP-683.8K-1
R57	Resistor, 216.2K, 1%	RP-216.2K-1
R58	Resistor, 138K, 1%	RP-138.0K-1
R59	Resistor, 68.5K, 1%	RP-68.4K-1
R60	Resistor, 198.6K, 1%	RP-198.6K-1
R61	Resistor, 31.6K, 1%	RP-31.6K-1
R62	Resistor, 40.98K, 1%	RP-40.98K-1
R63	Resistor, 28.2K, 1%	RP-28.2K-1
R64	Resistor, 40.98K, 1%	RP-40.98K-1
R65	Resistor, 10K, 1%	RP-10.0K-1
R66	Resistor, 40.98K, 1%	RP-40.98K-1
R67	Resistor, 21.62K, 1%	RP-21.62K-1
R68	Resistor, 28.13K, 1%	RP-28.13K-1
R69	Resistor, 68.4K, 1%	RP-68.4K-1
R70	Resistor, 47.56K, 1%	RP-47.56K-1
R71	Resistor, 7.5K, 5%	RC21-7.5K-5
R72	Resistor, 2.4K, 5%	RC21-2.4K-5
R73	Resistor, 2.4K, 5%	RC21-2.4K-5
R74	Resistor, 2.4K, 5%	RC21-2.4K-5
R75	Resistor, 6.8K	RC21-6.8K
R76	Resistor, 1.2K	RC21-1.2K
R77	Resistor, 1.2K	RC21-1.2K
R78	Resistor, variable, 25K	RCVM-25K

Circuit Reference	Description	HHS Part No.
R79	Resistor, 10K	RC21-10K
R80	Resistor, 50K, 1%	RP-50K-1
R81	Resistor, 17.5K, 1%	RP-17.5K-1
R82	Resistor, 600K, 1%	RP-600K-1
R83	Resistor, 17.5K, 1%	RP-17.5K-1
R84	Resistor, 22K	RC21-22K
R85	Resistor, 56K	RC21-56K
R86	Resistor, 56K	RC21-56K
R87	Resistor, 470K	RC21-470K
R88	Resistor, 21.62K, 1%	RP-21.62K-1
R89	Resistor, 10K	RC21-10K
S1	Switch, rotary, wafer	SRW-412-4
S2	Switch, rotary, wafer	SRW-85-3
S3	Switch, rotary, wafer	SRW-55-2
S4	Switch, rotary, wafer	SRW-23-5
S5	Switch, stock, momentary	SWS-2
V1	Tube, CK512AX, selected	V-CK512AX-A
V2	Tube, CK512AX, selected	V-CK512AX-C
V3	Tube, CK512AX, selected	V-CK512AX-B
V4	Tube, CK512AX, selected	V-CK512AX-D
W1	Cable, battery connector	WPC-9

B. 412X5 Vibration Accessory

Circuit Reference	Description	HHS Part No.
C1	Capacitor, 2200 pf.*	CM30-2200*
C2	Capacitor, 220 pf.	CM15-220
C3	Capacitor, 100 pf.	CM15-100
C4	Capacitor, .025 mfd., 2%	CPP-.025-2
C5	Capacitor, 22 pf.	CM15-22
C6	Capacitor, .012 mfd., 2%	CPP-.012-2
D1,2	Diode, 1N625	D-1N625
J-1	Connector, coaxial	J-12
J-2	Connector, output	J-5X-3M
J-3	Receptacle, AC	XAC-MR
R1	Resistor, 1 Meg	RC21-1M
R2	Resistor, 4.9K, 1%*	RP-4.9K-1*
R3	Resistor, 4.7 Meg, 1%	RP-4.7M-1
R4	Resistor, 10 Meg, 1%	RP-10M-1
R5	Resistor, 4.7 Meg, 1%	RP-4.7M-1
R6	Resistor, 1.99 Meg, 1%	RP-1.99M-1
R7	Resistor, 39 ohms*	RC21-39*
R8	Resistor, 12K	RC21-12K
R9	Resistor, 12K	RC21-12K
S-1	Switch, rotary, wafer	SRW-46
T1	Transformer, sub-miniature	TRA-M6
412-X5-P2	Pickup, vibration, with hardware and cable	412-X5-P2
(not shown)	Cord, calibration	WP-6XT
(not shown)	Chart, conversion	D-412X5

C. 412X5A Vibration Accessory

Circuit Reference	Description	HHS Part No.
C1	Capacitor, 150 pf, 5%	CM15-150-5
C2	Capacitor, 3000 pf, 2%	CM30-3000-2
C3	Capacitor, 3000 pf, 2%	CM30-3000-2
C4	Capacitor, 270 pf, 5%	CM15-270-5
J1	Connector, coaxial	J-12
J2	Connector, output	J-5-3MS
MT-1	Pickup, Vibration	412-X5-P2-
R1	Resistor, 1.0 Meg, 1%	RP-1M-1
R2	Resistor, 10 Meg, 1%	RP-10M-1
R3	Resistor, 10 Meg, 1%	RP-10M-1
R4	Resistor, 503K, 1%	RP-503K-1
S1	Switch, rotary, wafer	SRW-23-8
W-1	Cable, pickup	412-X5-P2-2
(not shown)	Case, leather	412-X5A-P3

D. 412X12 AC Power Supply

Circuit Reference	Description	HHS Part No.
C1	Capacitor, 100 mfd. @ 150v.	CET-100/150
C2	Capacitor, 10 mfd. @ 100v.	CETM-10/100
C3	Capacitor, .33 mfd. @ 100v.	CMS-.33/100
C4	Capacitor, 50 mfd. @ 50v.	CETM-50/50
C5	Capacitor, 1000 mfd. @ 15v.	CET-1000/15
C6	Capacitor, 1000 mfd. @ 15v.	CET-1000/15
C7	Capacitor, 10 mfd. @ 50v.	CETM-10/50
C8	Capacitor, 1000 mfd. @ 15v.	CET-1000/15
D1-4	Rectifier, TX400 (4)	D-TX400
D5	Zener diode, 1N726A	DZ-1N726A
D6-9	Rectifier, bridge, FW50 (1)	DB-FW50
D10-12	Diode, 1N625 (3)	D-1N625
F1	Fuse, slo-blo 1/16A	F-SB-1/16A
J-1,2	Jack, dual, phone (1)	J-3-D
J-3	Receptacle, 15 contact	J-15
PL-1,2	Plug, phone (chassis mt.) (2)	A-H-PG-1
PL-3	Cable, power, 3-wire	WP-6/3
Q1	Transistor, 2N4033	QA-11
Q2	Transistor, 2N3964	Q-2N3964
Q3	Transistor, 2N3019	QA-10
R1	Resistor, variable WW, 10K	RWV-10K
R2	Resistor, 10K	RC21-10K
R3	Resistor, 4.7K	RC21-4.7K
R4	Resistor, 12K	RC21-12K
R5	Resistor, 3.9K	RC21-3.9K
R6	Resistor, 18K	RC21-18K
R7	Resistor, 10 ohm	RC21-10
R8	Resistor, 22K	RC21-22K
R9	Not used	
R10	Resistor, 10 ohm	RC21-10
R11	Resistor, 68K	RC21-68K
S1	Switch, slide, DPST	SS-22-1
T1	Transformer, power	TR-2-1
V1	Lamp, neon indicator	V-SPL-NE-RF

Microphone & System Sensitivities

Type 412 Sound Level Meter

Sound Level Meter Serial No. _____

Ceramic Microphone Serial No. _____

Ceramic Microphone Open-Circuit Sensitivity _____ dB re 1V./microbar.

Ceramic Microphone **Effective** Sensitivity _____ db re IV./microbar.*

Sensitivity of Acoustic Calibrator (using external 600 ohm oscillator into J3 to produce 106 dB Sound Pressure Level). See Section V.D.1.

At 100 Hz _____ volts RMS

At 400 Hz _____ volts RMS

At 1000 Hz _____ volts RMS

Type 412X5 Vibration Accessory

412X5 Vibration Integrator Serial No. _____

Pickup Serial No. _____ Sensitivity _____ millivolts/g

Type 412X5A Vibration Accessory

412X5A Vibration Integrator Serial No. _____

Pickup Serial No. _____ Sensitivity _____ millivolts/g

Type 412X8 Wide Range Microphone

Microphone (Massa #M-141F) Serial No. _____

Effective Sensitivity –106 dB re IV./microbar with cable supplied, connected to 412 Input circuit.

Type 412X9 Dynamic Microphone System (Includes transformer supplied)

Microphone (Altec #684A Special) Serial No. _____

Sensitivity _____ dB re IV./microbar (with transformer).

Service Record

* **Effective Sensitivity** takes into account the loading effect of the 412 input capacitance and is **1.3 dB lower** than the open-circut sensitivity. The **Effective Sensitivity** is used for all calibration procedures in this manual. See Section V.D.2.b.

Warranty

GUARANTEE COVERAGE

H. H. Scott, Inc., instruments are guaranteed, unless otherwise stated, to be free from defects in workmanship and materials, excepting tubes, fuses, batteries, lamps, diodes, transistors and piezo-electric crystals for one year from date of purchase. This warranty protects our customers for a full year on both parts replacement and service time in our laboratory. We agree to remedy any defect within this period not caused by misuse, neglect, accident, improper installation, or use contrary to our instructions.

In case of older instruments no longer within the guarantee period we strongly recommend your instrument be returned to our factory for repairs. Our technicians know your instrument and will repair it at the least possible cost and with minimum delay.

REGISTERING GUARANTEE

The guarantee tag attached to the instrument must be returned to us within one week of purchase in order for the guarantee to become effective.

IF TROUBLE DEVELOPS

Experience has shown that the procedure below can save you needless shipping expense and/or unnecessary delay in the service of your instrument. Please cooperate with us so that we may give you better service. Follow the instructions below. Unless this is done THE GUARANTEE WILL BE VOID.

BEFORE RETURNING UNIT

Notify us, giving type and serial number of your instrument. Completely describe the defective operation. Describe the effects each operating control has upon the symptoms of trouble. Include details on electrical connections to associated equipment, and list such equipment.

Upon receiving this information, we shall send your shipping instructions, or service information if the trouble may be simple such as a bad vacuum tube, or if the difficulty seems to be in connections or associated equipment. Upon receipt of shipping information, please follow the instructions below.

HOW TO SHIP

CAUTION: Take particular care to cushion and pack your instrument well or serious damage may occur in shipment. Send the instrument to us fully-insured and prepaid. DO NOT SHIP VIA PARCEL POST unless so instructed by us. Your instrument will receive prompt and careful attention in our service laboratory, and it will be returned by express collect.

We are interested in your instrument.

Please do not hesitate to ask our advice or assistance.

SCOTT®